MACHINE DESIGN

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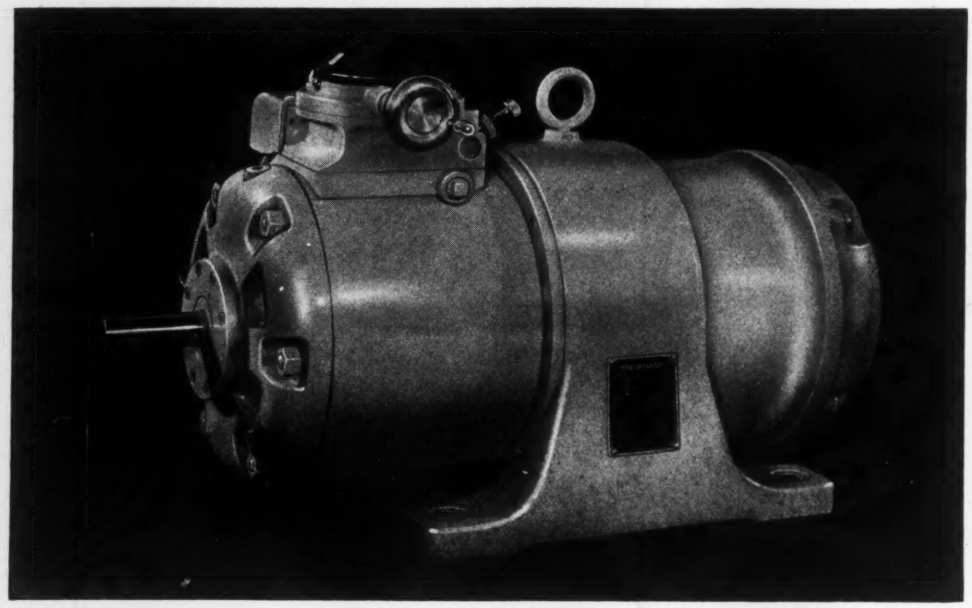

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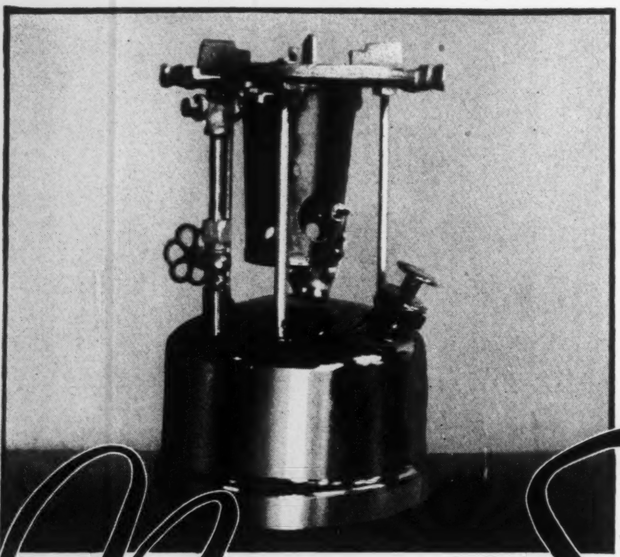

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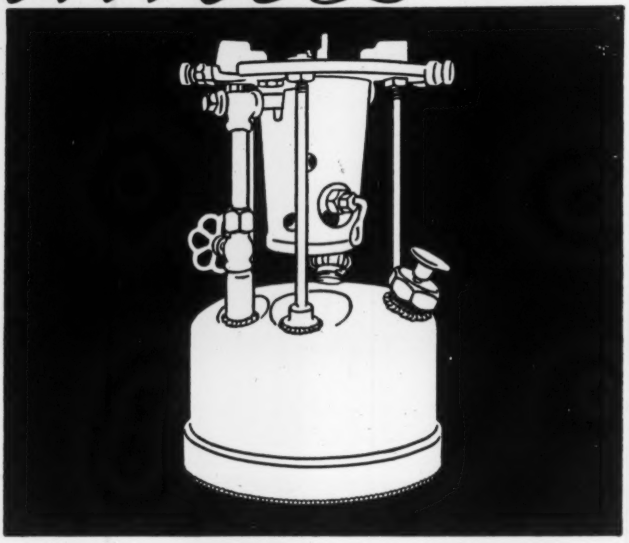

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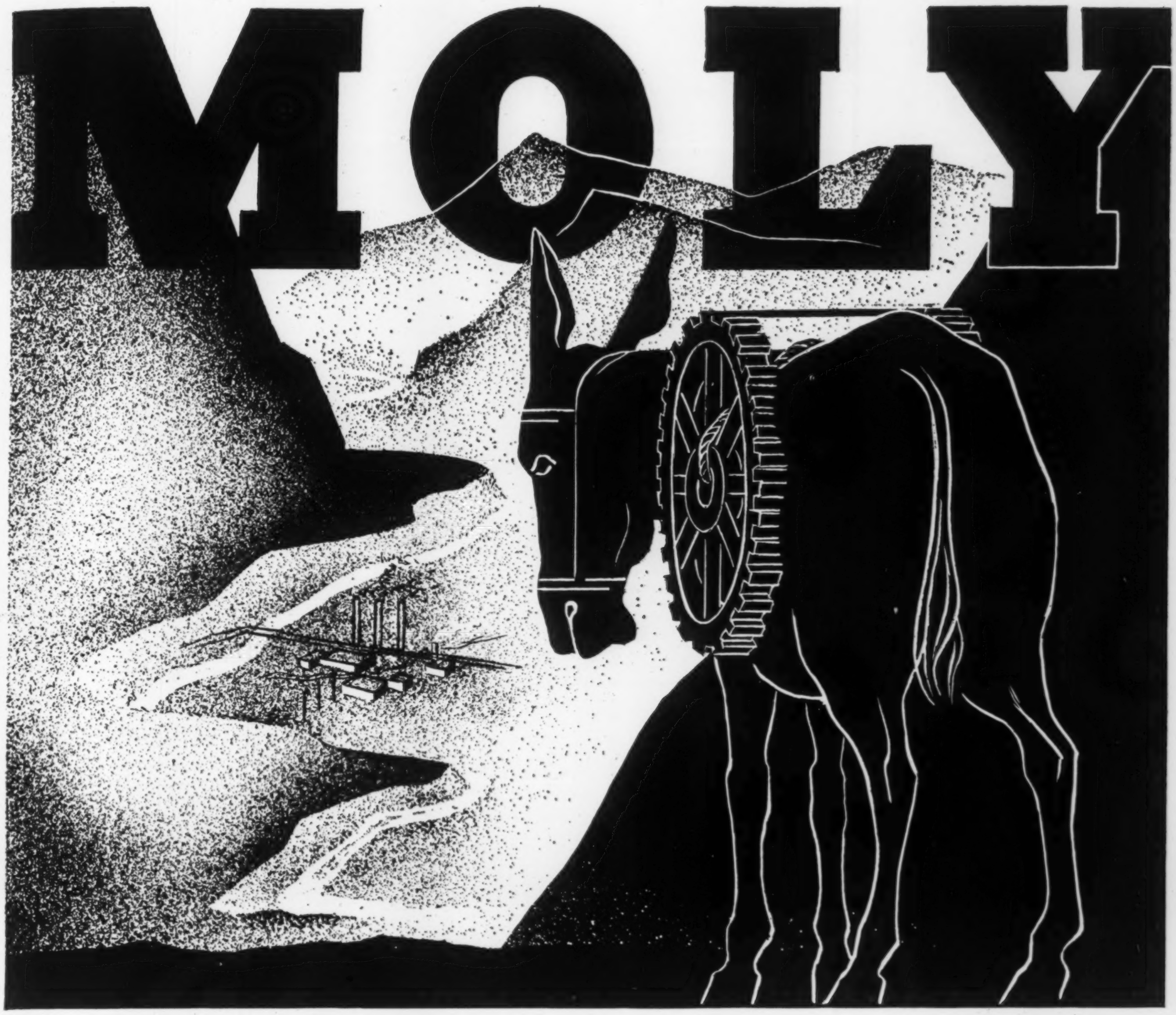

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CALENDAR OF MEETINGS AND EXPOSITIONS

JUNE, month of meetings, presents a year's progress in engineering development * * * Technical research, invaluable aid to design, will occupy the attention of Mechanical Engineers at University of Michigan. . . . J. L. Maulbetsch discusses thermal stresses in plates. . . . Fatigue of metals, bogeyman in material specifications, draws the attention of O. J. Horger, H. F. Moore and J. S. Ingles, and R. E. Peterson and A. M. Wahl . . . . the latter two presenting "Some Further Studies of Stress Concentration and Its Effect in Certain Fatigue Tests." . . . . Dr. Nadai will continue his contributions to technical data on "Creep of Metals". . . . With higher speeds comes the balancing problem. . . . W. E. Johnson gives "Method of Balancing Reciprocating Machines" * * * The annual meeting of American Society of Mechanical Engineers will be at Gibson hotel, Cincinnati . . . . Many subjects of interest to the profession as a whole are to be discussed . . . . Latest field invaded by mechanical engineers, "Mechanical Units for Houses" is the subject of D. C. Slipher . . . . R. V. Terry and D. C. Moorhead will present the design, fabrication, erection and operation of the Dnieprostroy turbines . . . Power transmission receives attention in papers on a new basis for the rating of roller chain drives by G. M. Bartlett, and the pivoted motor drive by R. R. Tatnall.

Automotive engineers at White Sulphur Springs will hear of "Trends in Automobile Design as Influenced by Fuel Volatility," by J. M. Campbell, W. G. Lovell and T. A. Boyd . . . "Cellular Rubber Cushions the Car," by H E. Elden . . . "Diesel Power for Transportation," by O. D. Trieber . . . . "Stresses in Connecting Rods and Bearings," by W. R. Griswold * * * Farm implements, their design and development, will be considered by American Society of Agricultural Engineers at University of Georgia * * * What the tests reveal, the design must follow . . . American Society for Testing Materials meets at Book-Cadillac, Detroit . . . Dr. Hirshfeld will present "Relation of Specifications to the Engineering Department" . . . Fatigue and creep occupy an important place on this program as well as on that of the Mechanical Engineers . . . . Creep characteristics of aluminum alloys is subject of R. R. Kennedy . . . . A. E. White, C. L. Clark and R. L. Wilson discuss influence of time on creep of steels.

June 16-21—

Society of Automotive Engineers. Annual summer meeting at White Sulphur Springs, W. Va. John A. C. Warner, 29 West Thirty-ninth street, New York, is secretary.

June 17-19—

American Society of Heating and Ventilating Engineers. Semiannual meeting at Royal York hotel, Toronto, Ontario, Canada. A. V. Hutchinson, 51 Madison avenue, New York, is secretary.

June 17-20—

American Society of Agricultural Engineers. Twenty-ninth annual meeting at University of Georgia, Athens, Ga. Raymond Olney, St. Joseph, Mich., secretary.

June 18-19—

American Society of Mechanical Engineers. Applied Mechanics division meeting at University of Michigan, Ann Arbor, Mich. Dr. S. Timoshenko of the university is in charge of the program.

June 18-21—

American Socity of Mechanical Engineers. Annual summer meeting at Hotel Gibson, Cincinnati. Clarence E. Davies, 29 West Thirty-ninth street, New York, secretary.

June 24-28—

American Institute of Electrical Engineers. Semiannual meeting at Cornell university, Ithaca, N. Y. H. H. Henline, 33 West Thirty-ninth street, New York, secretary.

June 24-28—

American Society for Testing Materials. Thirty-eighth annual meeting and exhibit of testing equipment at Book-Cadillac hotel, Detroit. C. L. Warwick, 260 South Broadstreet, Philadelphia, secretary.

June 24-28—

Great Lakes Power Show and Mechanical Exposition. On lake steamer SEEANDBEE at Buffalo June 25, Cleveland June 26, and Detroit June 27. Ernest H. Smith, 3910 Carnegie avenue, Cleveland, is manager.

Aug. 19-23—

American Foundrymen's association. Thirty-ninth annual convention at Royal York hotel, Toronto, Ontario, Canada. C. E. Hoyt, 222 West Adams street, Chicago, is secretary.

MACHINE DESIGN
THE JOHNSON PUBLISHING CO., CLEVELAND, OHIO
June, 1935 Vol. 7—No. 6

Avoid Waste of Material in Parts Design!

By V. L. Maleev
Professor of Mechanical Engineering, Oklahoma Agricultural and Mechanical College

First of a Four-Part Series

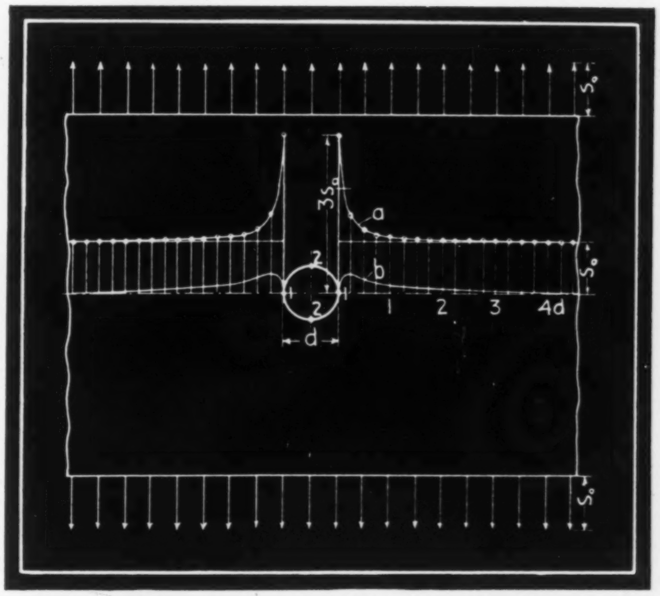


Fig. 1—Stress distribution due to a hole as found by theoretical analysis with a plate of infinite width

APPLICATION of the latest developments in the determination of stresses in materials used for machine parts allows the designer to obtain greater safety with smaller safety factors and often with smaller weights. In this article, the first of a four-part series, Professor Maleev introduces the general approach to the problem. Detailed developments will be included in later issues.

THE RAPIDLY growing competition between manufacturers of machines and the increase of the size of all machines make it imperative to avoid every waste of material, to design and make all parts as light as possible consistent with necessary strength and operating requirements, and to obtain a high efficiency of the utilization of materials. The steady tendency toward greater speeds in all technical applications, dictated chiefly by the same desire to build all machinery lighter, makes it doubly imperative to obtain minimum weights for all moving parts in order to reduce the forces of inertia set up by their masses. Any engineer who is keeping abreast of the technical progress through the technical magazines could not help but notice the great amount of research work done lately in regard to the behavior of engineering materials and of whole machine parts under various

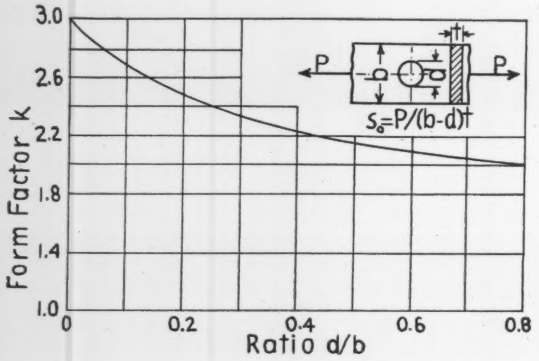


Fig. 2—Form factor due to a hole in a plate shows that a small hole has a greater effect than a large one

load conditions. This research work has given data in regard to such phenomena as stress distribution and stress concentration, endurance of materials, and creep. While in this country we are only studying these phenomena, the European engineers, particularly those in Germany, are putting to work this newly accumulated data.

Importance Should Be Stressed

Basically these ideas are not new. They are mentioned and briefly discussed in many American texts on machine design and in reference books. However, these books do not stress enough the importance of these factors and do not give sufficient data for their application in actual design. The object of the present article or rather series of articles, is to show how to make use of these factors. The following presentation carries a few steps further the correct approach indicated by Prof. W. K. Hatt[1]. This outline will show how to design machine parts with a factor of safety 1.5 to 2 and have them stronger than parts which were designed in the old-fashioned way using apparent factors of safety ranging from 6 to 25. It will show how a designer can have a real factor of safety instead of gambling with a factor of uncertainty or ignorance.

Definitions and Designations

A few definitions and concepts which are not yet commonly used are necessary to the correct approach to this problem, so these will be given before going into more detailed design calculations.

To bring out clearer the meaning of various formulas, stresses created in a member will be designated by small letters with or without a subscript, s, s_e or s_n; stresses which characterize the material will be designated by capital letters, such as S_e, S_u, or S_d.

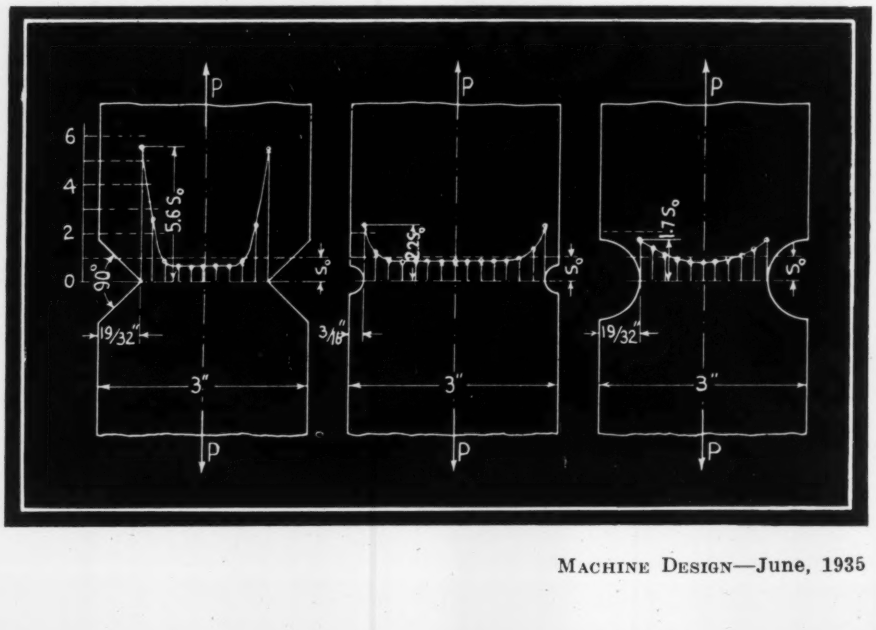
Nominal Stress—The stress computed by one of the elementary equations will be called the nominal stress and will be designated s_n.

Significant stress is the maximum stress which actually exists in a member and which determines its dimensions[2]. The significant stress s_{sg} is found taking into consideration such factors as load application, discontinuities in the sections, and also the properties of the material.

Limit stress will be called in general the maximum stress which can be induced in a machine part without damaging it. The limit stress S_l is a characteristic of the material but its value and method of determination depend upon the type of loading, thickness of the section, method of manufacturing, and surface conditions of the piece. For static loading the limit stress is equal to the elastic limit S_e; for repeated loads it is equal to the endurance limit S_{en}.

Design stress, also called working or allowable stress, is the maximum stress which can be set up in a properly designed machine part. To allow for inaccuracies in computations, workmanship, and qualities of the material, the design stress

Fig. 3—Typical stress concentration caused by notches and grooves in parts subject to tension



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[1] Marks', *Mechanical Engineer's Handbook*, McGraw-Hill, 3rd edition, 1930, p. 428.

[2] Seely, F. B., *Advanced Mechanics of Materials*, John Wiley, 1933, p. 1.

S_d should be always lower than the limit stress S_l.

Factor of Safety.—The amount by which S_d is kept below S_l is expressed by their ratio called the factor of safety.

$$f = S_l/S_d \qquad (1)$$

f may be called *design safety factor,* whereas the ratio

$$f' = S_l/s_{sg} \qquad (2)$$

is the *actual safety factor.* This definition of a safety factor differs from the one commonly used, which compares the nominal stress with the ultimate strength of the material. However, it is the more logical one and presents great advantages in respect to economy of material and actual safety. Thus, it shows clearly the superiority of high-grade alloy steels which, having the same ultimate strength as certain carbon steels, have higher elastic and endurance limits.

TABLE I

Size Factor for Mechanical Properties

Material	Ratio of S_{e_3}/S_e Natural state	An-nealed	Heat treated, drawn at 1200° Fahr.	 1000° Fahr.
Aluminum, strong, wrought	0.93	....	....	....
Tobin bronze	0.90	....	....	....
Monel metal, forged	0.80	....	....	....
Low-carbon steel, C<0.20%	0.84	....	....	....
Medium-carbon steel, 0.30-0.50% C	....	0 85	0 80	0.72
Nickel steel, SAE 2340	....	0.86	0.82	0.73
Cr-Ni-steel	....	0.87	0.84	0.75
Cast iron, class No. 20	0.60	....	....	....
Cast iron, class No. 25	0.73	....	....	....
Wrought iron	0.55	....	....	....

Size Factor.—Tests show that due to a decreased uniformity of structure, heavier sections of materials have lower mechanical properties, S_e, S_{en}, than smaller sections. The values given in various references were obtained with test specimens of small cross sections, about ½-inch.

As a first approximation, the elastic limit for all metals may be assumed to follow the law of an inclined straight line. In this case, if the elastic limit given in the table of a handbook is S_e, approximately corresponding to a section ½-inch thick, and the elastic limit of a 3-inch section S_{e_3} is known, the elastic limit S'_e for any thickness t between ½-inch and 3 inches can be presented by the equation

$$S'_e = S_e - (S_e - S_{e_3})(t - 0.5)/(3 - 0.5) \qquad (3)$$

or

$$S'_e = e_{sz}S_e \qquad (4)$$

where the *size coefficient* e_{s_z} may be found from the expression

$$e_{sz} = 1 - 0.4(1 - S_{e_3}/S_e)(t - 0.5) \qquad (5)$$

TABLE I gives the ratios of S_{e_3}/S_e for a few of the more important materials.

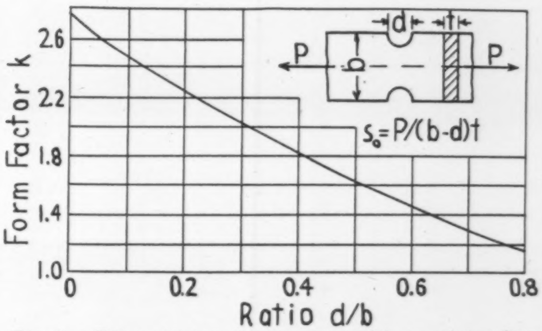


Fig 4—Form factor in a part with semicircular notches

Explains Stress Concentration

When adjacent sections are changing abruptly, as when the piece has a hole, a notch, a groove, or a small section joining a larger one, then the unit stress in the section ceases to be uniform, the fibers closest to the abrupt change in the section are stressed higher than those which are further from the affected point. This phenomenon is called *stress concentration* and the change of section causing it is called a *discontinuity.*

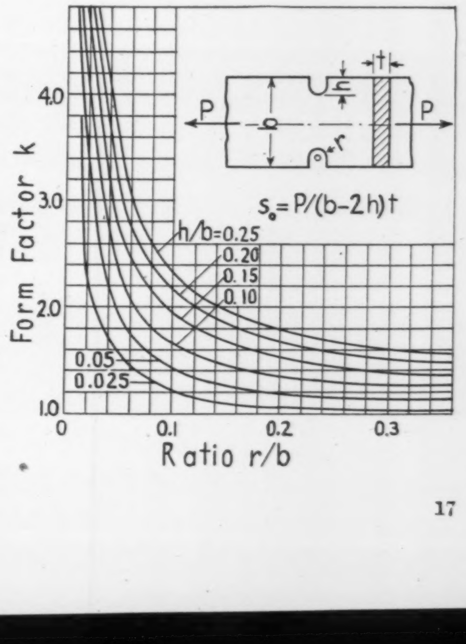
If s_0 is the uniform stress in a section without a discontinuity and s_1 the stress at the point affected mostly by the discontinuity, then

$$s_1 = ks_0 \qquad (6)$$

where k is the stress concentration factor. Thus, the stress concentration factor indicates the increase of the stress as compared with the nominal stress computed with the assumption of a uniform stress distribution.

Numerically, the factor k depends upon the character and relative size of the discontinuity. Since k is a function solely of the geometrical form of adjoining sections it is more convenient to denote it the *form factor* in order to distinguish it from actual stress concentration factors found experimentally for various metals at different load conditions. The form factor is determined either by a mathematical analysis or by

Fig. 5 — Form factors due to notches of different shape



special experimental methods among which the most important are the photoelastic[3] [4] and the soap-film methods[4].

Due to the equalizing effect of elasticity and plasticity of the materials the values of stress concentration factors found experimentally in metal specimens are lower than those of the corresponding theoretical form factors.

Stress concentration due to a discontinuity occurs whether the stress comes from a direct load, or from bending, or torsion.

Discontinuities and Form Factors

In these articles only the three most important cases of discontinuities will be briefly discussed and methods given for evaluating their influence. These are: Holes, notches, and junctures of different size sections. In accordance with the three types of stresses they will be discussed separately for direct stresses, tension or compression, bending, and torsion.

The stress distribution around a hole as found by a theoretical analysis with a plate of infinite width is illustrated by *Fig.* 1. At the edge of the hole, points 1, 1, $k=3$ and from there the stress gradually decreases approaching assymptotically s_0. If the width of the plate is b, the value of k decreases with the increase of the ratio d/b, where d is the diameter of the hole. The relation between d/b and k is shown in the diagram of *Fig.* 2. Thus theoretically a small hole has a greater effect than a large one. Actually the effect of a small hole, under ⅛-inch, is not as great as of a larger one.

Notches in flat pieces and cylindrical grooves in round bars have an effect similar to that of holes. The form factor depends upon the depth of the notch or groove as well as its shape. *Fig.* 3 shows typical stress concentration due to tension. *Fig.* 4 gives numerical data referred to the relative size of semicircular notches[5] and *Fig.* 5 those for notches of various relative depth h and radius r at the bottom[6].

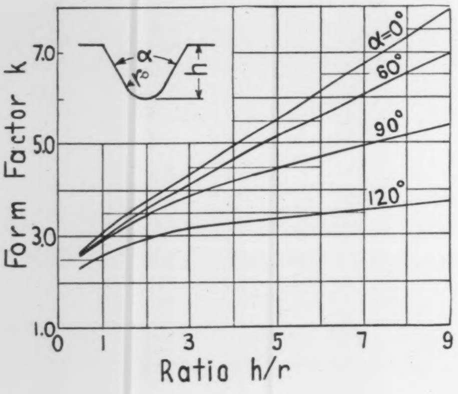


Fig. 6—Notches of varying shape produce varying form factors

For small notches the form factor can be computed from[7]

$$k = 1 + 2\sqrt{h/r} \qquad (7)$$

Fig. 6 gives values of k for notches having various shapes particularly in regard to the angle between the sides[8]; these curves are referred to an infinite width b but may serve to estimate the correction of the value of k found from curves *Figs.* 4 and 5 if the sides of the notch are not parallel.

The influence of fillets depends upon the relative size of the fillet, as expressed by the ratio r/h, *Fig* 7, and the relative size of the rib, as expressed by the ratio H/h. With usual fillets, $r/h = 0.05$ to 0.5, for $H/h = 3$ and greater the form factor ceases to depend upon H/h and may be presented by the curve a[9]. For smaller ratios H/h its values are lower.

Screw threads theoretically are similar in their effect to sharp circular grooves. The shapes of various threads were established before the effect of stress concentration was discovered or recognized and the factors k are rather high.

EXAMPLE 1.—Determine the form factor for a plate 4 inches wide loaded in tension and having two symmetrical notches in the main cross section, ½-inch deep, with a radius of ⅛-inch at the bottom and with the sides at 90-degree angles.

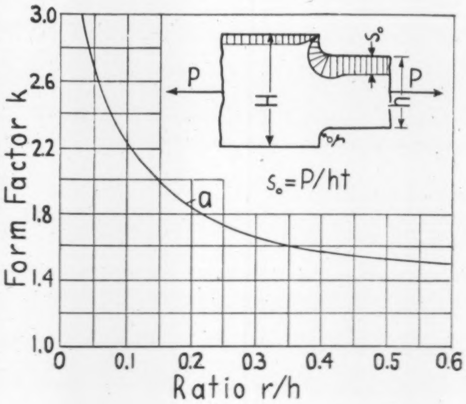


Fig. 7—Tension stresses develop these typical form factors

From *Fig.* 5 for $h/b = 0.5/4 = 0.125$ and $r/b = 0.125/4 = 0.031$ the form factor $k = 3.4$.

The influence of the 90-degree flare-out can be found from *Fig.* 6 for $h/r = 0.5/0.125 = 4$ and comparing the 0 and 90-degree sides, as $4.2/4.9 = 0.857$. Therefore the corrected value of the form factor

$$k = 3.4 \times 0.857 = 2.92$$

The employment of these data in design calculations as well as a further discussion of the concepts including discontinuities in bending and discontinuities and torsion will be presented in the next article in this series.

To be continued in the July issue.

---

[3] Frocht, M. M., *Trans. A.S.M.E.*, 1931, APM-53-11, p. 135.

[4] Seely, F. B., *Adv. Mech.*, p. 184 etc.

[5] Wahl, A. M. and R. Beevwkes, Jr., *Trans. A.S.M.E.*, 1934, APM-56-11, p. 621.

[6] Lehr, E., *Spannungsverteilung in Konstruktionselementen*, Berlin, 1934, Table 4, Fig. 18.

[7] Peterson, R. E., *Trans. A.S.M.E.*, 1933, APM-55-19, p. 161.

[8] *Marks' Handbook*, p. 421.

[9] Weibel, E. E., *Trans. A.S.M.E.*, 1934, APM-56-13, p. 641.

SCANNING THE FIELD FOR IDEAS

HOME SHOWS MACHINE INFLUENCE

ENGINEERS' contributions to the modern home can be measured in increased comforts, utility and beautification. Traditional and antiquated practices in home building are giving way to scientific planning by which the structure and its accoutrements now are being treated as a complete unit. In other words the home is becoming an inhabitable machine.

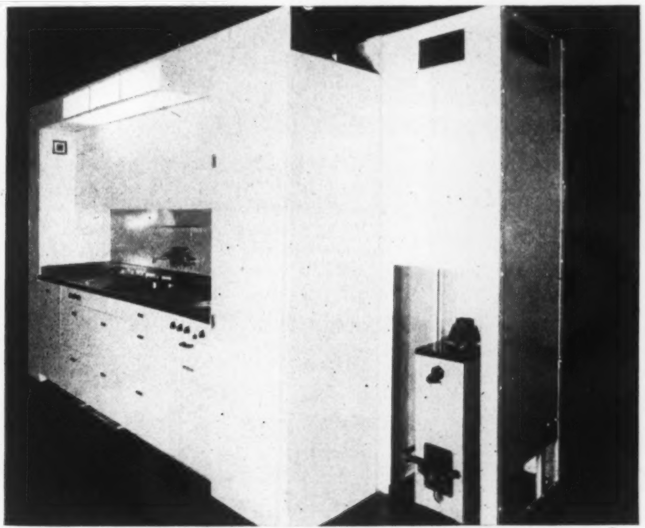


Fig. 1—Plumbing, heating, air conditioning and other devices for the home are contained in this mechanical nerve center

Motohomes, the American Houses Inc. calls its innovation. In this development the ingenuity of the engineer is particularly apparent. The "Magic Moto-Unit," *Fig.* 1, reflects the influence of the machine in designing this type of house. Virtually the mechanical nerve center of the Motohome, this Moto-Unit contains the plumbing, heating, air conditioning, and other electrical and mechanical devices for the entire house. What could better illustrate unit construction, a trend that has been responsible for improved operation of many outstanding machines discussed in these columns in the past?

The complete assembly of the foregoing equipment in a large metal cabinet, as illustrated, is the central structure around which the house is built. One side becomes the kitchen and the other side the bathroom, with the other rooms adjoining. Flexibility is another feature of this project. If additional space is desired at some later time any of the sides or corners may be "unbuttoned" and extra rooms added. Exterior walls are made of two slabs of cement and asbestos compressed under hydraulic pressure with integral insulation, and are fastened to the frame of the house which is steel.

Another house that has been attracting attention is that developed by Berger Mfg. Co., a subsidiary of Republic Steel Corp. In keeping with modern architecture, roofs of the houses are flat and basements have been eliminated. One of the features is a plumbing stack or chase, a self-contained box-like unit incorporating all water pipes, vents and flues, which serves both kitchen and bath and becomes an integral part of the house wall. All kitchen equipment is placed along one wall. Hot or cool air, depending on the season, is circulated throughout the house in ducts built into the steel frames.

The surface only is scratched; still more revolutionary developments may be expected.

UNBALANCED PARTS ADVANTAGEOUS

BY UNBALANCING a mechanism through the use of weights rotating at the same speed but in opposite directions, a mechanical device has been designed for imparting a horizontal shaking or screening motion to sieves or conveyors. The two weights, geared together as shown

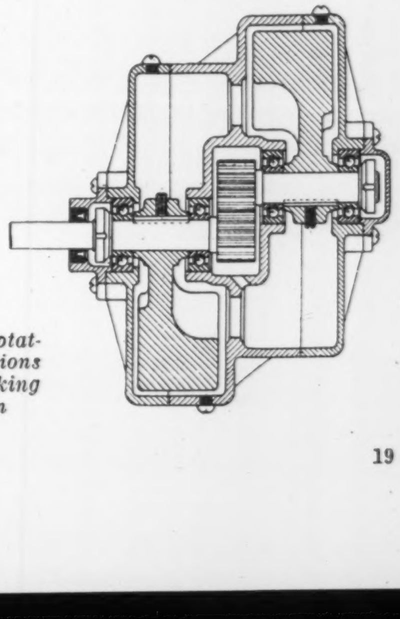


Fig. 2—Two weights rotating in opposite directions impart horizontal shaking or screening motion

in *Fig.* 2, are segmental in form and operate in a dustproof enclosure.

Gear housing and inner bearing support member are cast integral with the central frame portion, thus insuring true alignment of gears and driving shafts. Outer bearing support is integral with the end closing member. Cylindrical construction of the housing provides maximum rigidity for the entire unit. Either belt or direct drive can be used.

The device, developed by Ajax Flexible Coupling Co., Westfield, N. Y., is employed extensively in the separation of grain, gravel, sand and other dry materials. Two or more of these units may be operated in parallel.

PRODUCING PRESSURE ELECTRICALLY

BECAUSE it is designed for electric instead of compressed air operation, a grease gun, new on the market, exemplifies the trend toward increased portability. Electric current is almost universally available while sources of compressed air are still more or less limited in number.

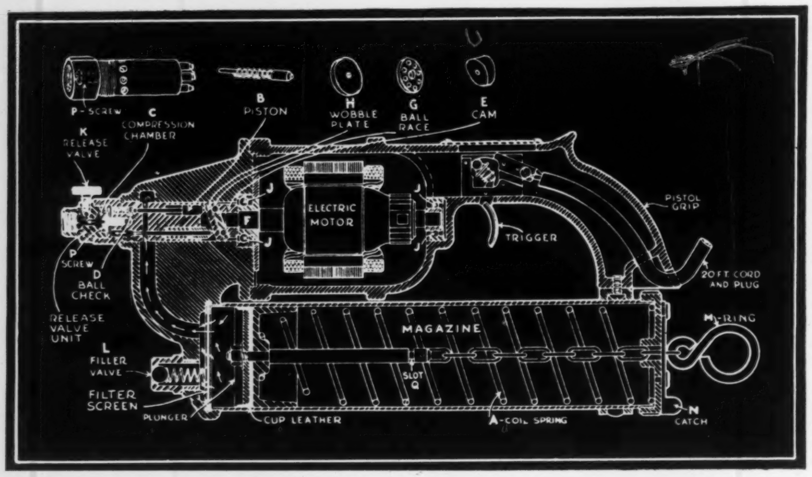


Fig. 3—*In this electric grease gun a cam at the end of the motor shaft actuates four small pistons which force grease into a compression chamber where pressure is built up and maintained by four ball check valves*

In this grease gun, *Fig.* 3, a large coil spring *A* in the magazine forces grease up to pistons *B* of which there are four, but only two shown. These are compressed to deliver a tiny drop at a time into compression chamber *C* where pressure is maintained by ball checks *D*. Cam *E* at the end of motor shaft *F* through ball race *G* actuates wabble plate *H* that alternately compresses and releases the four pistons *B*. Rotary movement of the cam is absorbed in the ball race so that the wabble plate does not rotate, thus giving a frictionless contact between the wabble plate and the pistons.

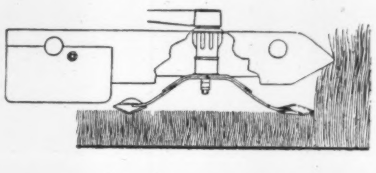
Release valve *K* is employed when lubricating pin fittings, or to release imprisoned air should the gun become air-bound. The gun is loaded with a filler, grease entering through filler valve *L*. When loaded by hand, spring *A* is compressed by a pull on ring *M* and locked in compressed position with catch *N* which engages in slot *Q*, so that the magazine can be unscrewed and the gun filled. After the magazine has been replaced, catch *N* is released to bring spring pressure against the grease, and the gun is ready to operate.

The Weaver Mfg. Co. developed the unit, which is equipped with a universal motor that develops 10,000 revolutions per minute. The gun delivers 40,000 tiny shots of grease a minute, amounting to a continuous flow of lubricant.

SCYTHE ACTION IN MOWER DESIGN

INASMUCH as the average engineer has little regard for lawn mowing, there is gratification in the fact that a newcomer in this class of equipment yields something besides an opportunity to work up a good sweat. The unique idea employed in the interesting Whirlwind power mower, *Fig.* 4, should more than compensate for the mention of this tender subject. The machine utilizes a principle that incorporates a rotary scythe action which cuts excessively tall grass and weeds with ease. The cutting unit consists of an arm revolving at 1800 revolutions per minute. On each end of the arm is a three-inch blade, the rear edge of which is curled upward slightly to create suction that is claimed to cause the grass to be drawn into the cutter.

Fig. 4—*An arm equipped with cutter blades revolving at 1800 revolutions per minute in a horizontal plane is significant feature of power mower*



Power is transmitted to the cutter arm shaft by a flat belt driven by a gasoline engine. Ball bearings are employed. Width of cut is twenty-two inches. This revolutionary idea in lawn mowers is indicative of departures from traditional design.

UTILIZING A HOLLOW BALL

SIMPLIFIED design, attained through the use of a spherical steel casing for housing the compressor as a hermetically sealed unit, is exemplified by the new General Electric "Ball Top" refrigerator, *Fig* 5. The design motif follows the Monitor Top, except that the condenser is located in the upper section of the cabinet and acts as a foundation for the ball. In the Monitor model the condenser assembly surrounds the compressor housing.

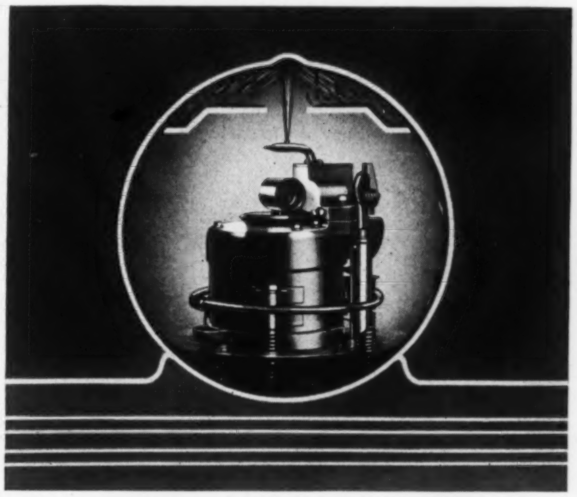


Fig. 5—Cabinet top condenser supports "ball top" in which refrigerating mechanism is hermetically sealed

Appearance of the machine crowned with the ball is pleasingly modern. All surfaces are smooth and exposed, making the entire exterior easy to clean. Essentially, the compressor unit in the new model is the same as that in the Monitor refrigerator.

As shown in *Fig.* 5, the mechanism is lubricated and cooled by a force feed oil system, a quantity of lubricant being permanently sealed in the spherical housing for this purpose. Cooling of the oil takes places as it runs down the inside of the housing. This is of particular advantage inasmuch as it not only dissipates the heat generated by the compressor, but more rapidly transfers the heat absorbed by the refrigerant because it provides a more positive path of travel than the refrigerant alone.

FLEXIBLE GLASS ARRIVES!

GLASS that will bend like a sheet of steel is the answer to many an engineer's prayer. Recent development of a new material of this type brings to mind its enormous commercial possibilities. Described as the world's hardest glass, it is heat treated in a new electric furnace designed especially for the strengthening process. The Libby-Owens-Ford Glass Co., Toledo, O., is one of two companies with licenses permitting manufacture and use of the process in the United States. The Toledo concern is installing two of the English furnaces in its Ottawa, Ill., plant.

Treatment consists of placing a sheet of ordinary plate glass in the furnace and heating it until it becomes plastic. Then a cold blast of air suddenly is directed against it, creating high strain. This process develops high compression on the outer wall of the glass, while the interior is under tension. Such procedure is said to give the glass a strength from four to six times that of ordinary glass. The material will support tremendous weight, can be twisted or bent and will resist breakage to an unbelieveable degree, the announcement states. It is, of course, breakable when an extraordinary force is brought to bear, but when it does break the glass crumbles into small fragments like rock candy.

Dame rumor has it that there now is on the market an electric light bulb that will "bounce." Whether the new development makes use of a special glass we are not prepared to say. At any rate the report is interesting and ties in very well with the announcement of the flexible glass discussed in the foregoing.

SPHERICAL FACES GIVE SPEED CONTROL

TRANSMISSION of power through hardened steel rollers in pressure contact with steel races follows a well known principle. A common example is the locomotive which acquires

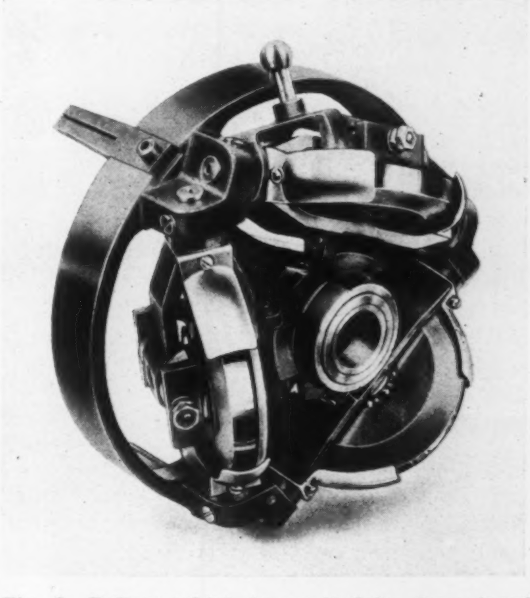


Fig. 6—Rollers which transmit drive from input to output race are mounted in a spider

tractive effort through adhesive contact between its wheels and the rails. In the adaptation of this basic idea to the "Transitorq" power unit developed by New Departure, however, it is recognized that the positive rolling contact of the rollers and races of the drive, or the traction of one on the other, will not be interrupted so long as pressure of the rollers on the races is proportional to the torque load or tangential force. Therefore, an automatic pressure device is employed which utilizes the imposed torque load itself to generate the required contact pressure.

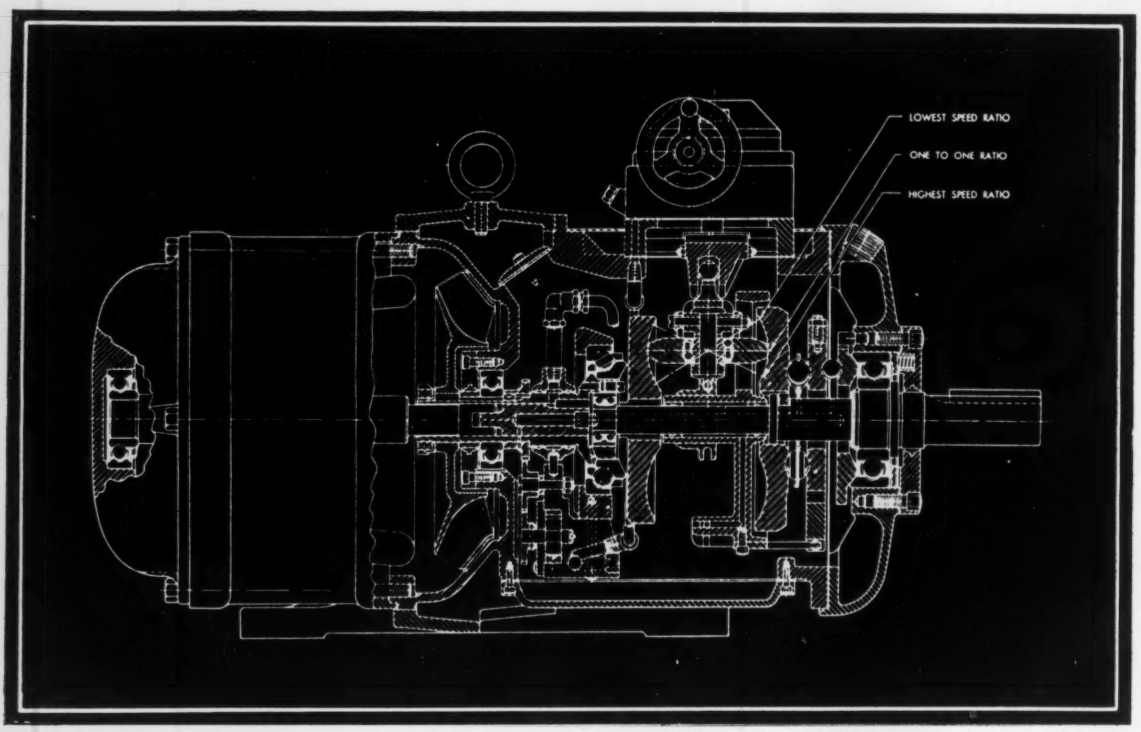


Fig. 7—Section through variable speed power unit shows how rollers may be adjusted to any position relative to the races

Rollers which transmit the drive from the constant speed input race to the variable speed output race, *Fig.* 7, are mounted in a non-rotatable spider, *Fig.* 6 . Each roller, being carried on a ball bearing, is free to revolve about its own axis and in addition may be rocked a limited distance about an axis at right angles to it. As a result the rollers may be adjusted to any position relative to the races from the lowest to the highest speed positions. It is obvious that in thus changing the inclined position of the rollers with regard to the races, not only is the speed of the output race changed but any speed within the limits of the low and high speed roller positions may be had accurately.

In the device for regulating the contact pressure of the rollers on the races, a stationary and a floating torque-loading flange, mounted alongside one another on the driven shaft, are separated by three balls equally spaced in inclined grooves. Because of the cam formation of these grooves a slight rotary movement of the floating flange in relation to the stationary flange in either direction causes a definite axial movement which is communicated as thrust to the variable speed output race. Since the latter race is located axially only by an angular contact bearing on one side and the rollers on the other, it is evident that the thrust will result in an increase in contact pressure between the races and the rollers. Traction or driving forces between both input and output races and the rollers act in the same direction, and the reaction tends to rotate the spider which carries the rollers, *Fig.* 6. This tendency toward rotation is imparted to the floating flange by three steel fingers; thus any change in the imposed torque, whether due to sudden shock load or simply a gradual load increase, results in a change in roller tractive effort, a corresponding partial rotation of the torque flange and a definite increase in the roller contact pressure.

Use of nickel-chromium-molybdenum steel cylinders strong enough to carry gas under 3000 pounds pressure has given impetus to the development of the gas-operated automobile in England. This type of car has been in operation in that country for a number of years. Because gas made from coal is a cheap native fuel, whereas gasoline must be imported, the idea is extremely practical. Two cylinders for carrying the fuel gas are slung under the chassis of the car.

Aluminum Favored in Comet Design

USHERED in largely by the development of new light weight alloys, the unique streamlined trains now so much in the public eye bring new laurels to design engineering. Technicians have been given a free hand in this new venture with the result that ideas are fresh and have not been hamstrung by tradition. The diesel-operated Comet, recently completed by the New York, New Haven and Hartford Railroad Co., for instance, is constructed as a tube with flat sides and well arched roof and bottom, all shear and compression stresses being absorbed by the outer surface or skin. Heretofore, it has been conventional to build railroad cars on either the center sill or the truss principle.

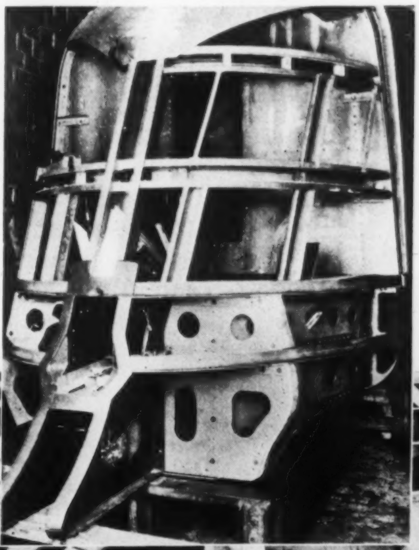
Strong alloys of aluminum make up the major structural materials. Extruded shapes, flat and formed sheets and castings have been employed effectively. Aluminum rivets are used throughout for attaching all aluminum parts. In the truss type of construction, *Fig*. 1, a rigid framework similar to the ordinary steel bridge in appearance is depended upon to carry the load and withstand the shocks.

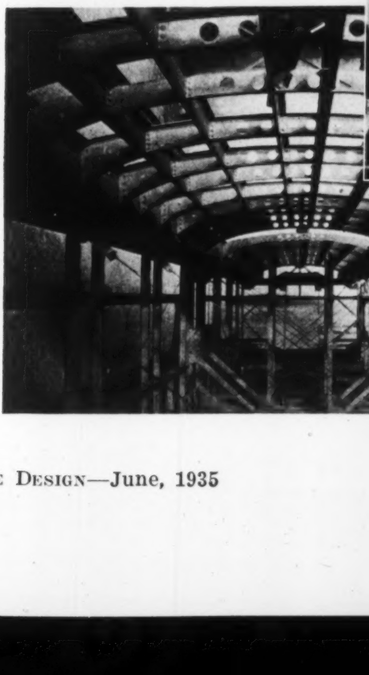
At points of articulation the body structure is connected by a heavy aluminum alloy bulkhead, the bottom part of which is formed by a welded high tensile steel endsill. This member ties in with the lower booms and distributes the loads from the center bearing and side bearings, which are integral parts of the endsill, into the end bulkhead and car body. The floor or underframe, *Fig*. 3, of the car is similar to a ship's bottom. Two lower boom sections are connected by lateral bulkheads which are braced by longitudinal bulkheads, forming a series of rectangular compartments in which various parts of equipment are located. Side posts are connected to the top and bottom boom sections with heavy brackets to insure good shear connection. A series of pressed sections hold the two upper boom sections together.

Insulating Materials Employed

Another interesting feature is the use of insulating materials. Space between the inner and outer covers, about three inches thick, is filled with insulation against heat and sound. Nicolfelt has been cemented to both inner and outer sheets and the space between has been filled with Alfol. End bulkheads, air conditioning ducts and the under structure also have been insulated.

Westinghouse air brakes are used, and hydraulic shock absorbers are employed instead of the usual leaf or elliptical springs. The trucks themselves are orthodox cast and welded steel.





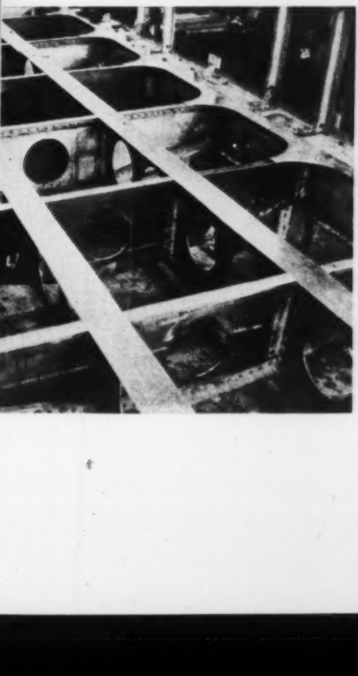


Fig. 1—Lower Left—Roof structure embodies aluminum longitudinal members

Fig. 2—Center—Head end of one of the power cars, showing framework of aluminum cab and the steel pilot

Fig. 3—Lower Right—Underframe is similar to a ship's double bottom

Maintain Open Attitude in Selecting Materials!

By H. F. Allen

IRON and steel together form the largest manufactured product in the world. Each enters into every branch of industry and is a necessary factor in every phase of our civilization. Ferrous castings are produced in almost every city of the United States and their uses seem unlimited. In no other craft or profession does there exist such extremes in sizes of product, ranging from small chain link, some of which weigh as little as 0.05 ounce, to enormous base plates and frames weighing over 100 tons.

The Link-Belt Co., with which the author is associated, is an engineering concern that is in the peculiar position of making many types of ferrous castings. We operate a large malleable, two gray iron, and two steel foundries, and produce a wide variety of castings to meet the demands of varied products. Therefore the author holds no brief for any specific kind of ferrous casting. In fact, it often is difficult to choose between two or more analyses as any one of them would accomplish the desired result. Individual opinions or preference, or the facilities of the foundry making that casting, are the determining factors.

THERE are three groups of ferrous castings, gray iron, malleable iron and steel, each of which can be further divided by the addition of alloying elements. Choice should be made only after careful study of the materials. The author, engineer, Link-Belt Co., presented the paper from which this article is abstracted as part of a recent lecture course of Chicago section, American Foundrymen's association.

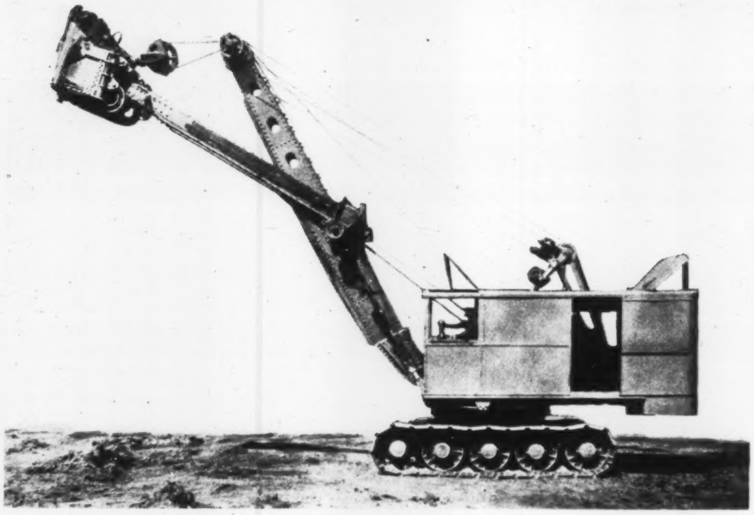


Fig. 1—Many ferrous castings are employed in a power shovel

Let us discuss a specific design problem of a piece of equipment made of a large number of various ferrous castings. For this example we might choose a power shovel such as is illustrated in *Fig.* 1 and of which general type there are many thousands in operation on construction work throughout the country. As such machines must be transported either by railroad, trailer, or under their own power from job to job, clearance dimensions and weight are extremely important in a consideration of their mobility. These matters all play a part in the design and selection of materials used in their construction.

Illustrated in *Fig.* 1 is a machine rated at 1¾ cubic yard capacity and has a working rate of 57 tons. Approximately 80 per cent of the weight of this machine is castings, and 85 per cent of the castings are high grade carbon or alloy steel.

The dipper of a power shovel is subjected to considerable impact and abrasion. This is particularly true of the lip and teeth. It is becoming rather general practice for dippers for machines of the size shown in *Fig.* 1 to be made entirely of manganese steel. This steel, with its work hardening properties, is manifestly a logical selection for the service imposed. Many

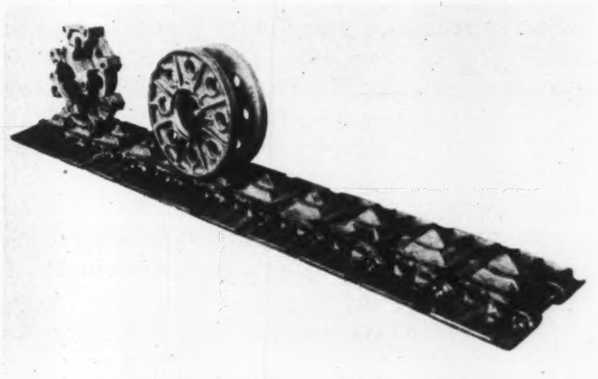
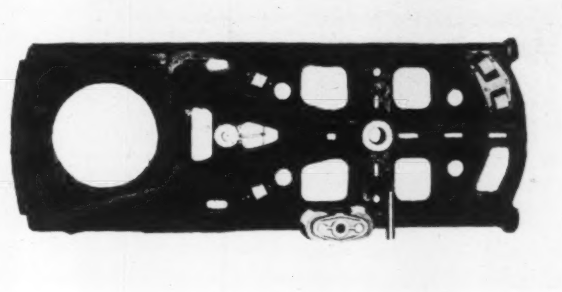


Fig. 2—Distribution of machine weight over a large area is accomplished by treads

Fig. 3—Medium carbon steel casting fulfills requirements of rotating platform



dippers are made up of a combination of steel plate and manganese steel castings for the wearing parts.

Treads, or caterpillars as they are frequently called, are the continuous chain or belt, *Fig.* 2, which serve to distribute the weight of the machine over a large area and thus make it possible to traverse soils having low bearing values.

It is apparent that under certain conditions of loading, tremendous pressure is concentrated upon this roller track. Also, there may be considerable abrasion due to rock and gravel getting between the rollers and the track. This abrasive material is also picked up by the shoes and carried up into the sprocket where a grinding action takes place between the sprocket teeth and the driving lugs upon the tread. While the lower face of the tread need not be unusually hard or resistant to abrasion, it is highly desirable that the track and lugs have such properties. A chrome or chrome-nickel steel tread, which has been differentially heat treated to give the required hardness on the upper side, makes a very satisfactory shoe. Manganese steel is also used to a considerable extent for this purpose and probably has as many advocates as does the heat-treated alloy shoe.

Note the peculiar shape of the sprocket. Offsetting the driving teeth is for the purpose of relieving the sprocket from the material carried up by the treads and making it as self-cleaning as is possible. Tremendous loads, sufficient to propel one of these machines up a 30 per cent grade, are exerted between these sprocket teeth and the driving lugs on the treads. Any material carried by the treads will create an extremely abrasive condition and therefore these sprocket teeth, in addition to strength, must possess abrasive resisting properties. Considerable machine work is required upon these sprockets and therefore a manganese steel is difficult to use. A chrome or a chrome-nickel steel with the periphery differentially heat treated to the correct hardness while the center portion remains comparatively soft for machining, or a heat-treated steel within range of machinability, answers the purpose.

One-Piece Casting Employed

Mounted on the top of the lower frame of the power shovel, is the combination roller path, gear ring, and center casting, shown in *Fig.* 4, upon, by, and about which, rotation of the upper structure is accomplished. The purpose in casting these three essential parts as one piece is the insurance that they will be machined and mounted absolutely concentric with one another, a very necessary and important feature. A steel casting fulfills the requirements of this part. The roller path must be hard and strong to withstand the high rotating roller loads and the pounding which must result as the loads at the end of the boom are alternately applied and released. It is also important that the gear teeth be adequate to withstand the impact due to the sudden reversals of the swing mechanism. We have found a 0.40 per cent carbon chrome steel quite satisfactory for this purpose.

All of the main machinery with the exception of the lower frame and propelling mechanism is mounted upon a rotating platform, *Fig.* 3, as is also the power plant (usually, a gasoline or oil engine), the boom, sockets, and the masts and

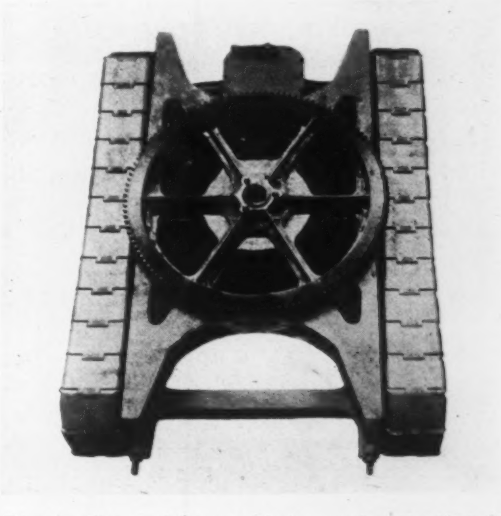


Fig. 4—Concentric machining and mounting is insured by composite casting

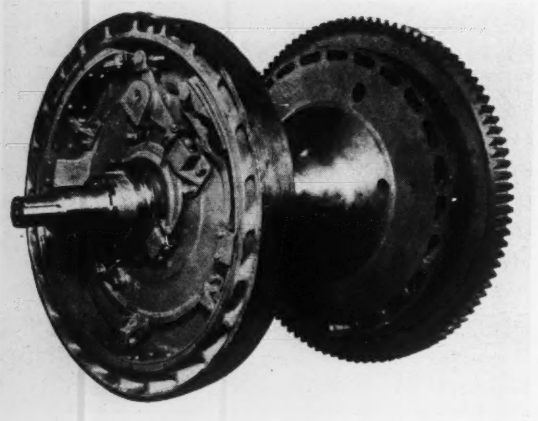
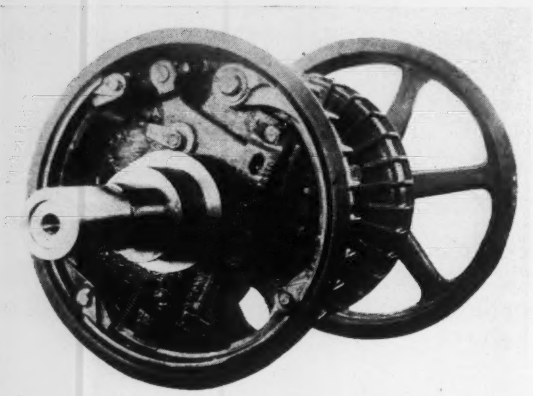


Fig. 5—Nickel iron provides torque transmitting strength

Fig. 6—Dissipation of heat is necessary in clutch shells



stays or "A" frame. To maintain the necessary permanent rigidity for the proper alignment of the machinery and to take care of an unusual combination of loading due to boom, roller, masts and stay reactions, the natural and logical selection is a single piece steel casting. It eliminates joints which loosen up in time, permits the proper distribution of metal to take care of the stresses in the most direct manner, and presents a unit piece that can be handled expeditiously for machining, and afterward for the assembly and proper alignment of the mounted machinery. A medium carbon steel casting usually fulfills these requirements very well, although in the interest of light weight, it is sometimes desirable to add an alloying material with proper heat treatment. Sometimes the increase in cost of such an alloy casting is more than offset by the saving in weight.

The drum spider, *Fig.* 5, must act as a clutch drum for the friction clutch used for hoisting the load and also as a drum for the brake used in lowering the load. Steel does not make a very satisfactory brake or clutch drum as there is a galling tendency due to small particles of the steel becoming embedded in the brake or clutch lining which results in scoring. On the other hand, these drum spiders must possess sufficient strength to transmit a considerable amount of torque. They must possess good machining qualities so that a smooth clutch and brake surface may be obtained. Spongy spots must be absent or the clutch and brake surfaces will be impaired, resulting in rapid lining wear. A nickel cast iron has proved to be a very satisfactory answer to this problem. The castings are sound, quite readily machinable, take a good polish, and possess the necessary strength.

Castings used for the clutch shells, *Fig.* 6, for the functions of rotating and traveling present a somewhat similar, yet different, problem than do the main hoisting drumshells. The torque which these shells must transmit is considerably smaller than that transmitted by the drums, but, on the other hand, the rubbing speed of the clutch lining against its surface is considerably greater, the clutch is much smaller in diameter and there is less mass and cooling surface for dissipation of the heat. These clutches are applied from three to four times per minute and must absorb and dissipate a considerable amount of heat in starting and stopping the machine. When these clutches are applied suddenly and frequently, the skin of the metal next to the lining may become red hot, although the outer surface of the drum may be cool.

Alloy Iron Is Utilized

Obviously this localized heating of the inner surface eventually produces checks and cracks in ordinary mixtures, with resulting ruin of the lining. The nickel iron such as referred to in connection with the hoist drum clutches has been reasonably satisfactory, but further experimentation has indicated that the addition of a small amount of molybdenum and chromium in addition to the nickel has vastly improved the results and that such compositions show much less wear than a high grade of chrome-nickel iron. This is, no doubt, due to the property of the molybdenum to reduce the tendency of growth under temperature with the resultant checking or cracking.

The clutch illustrated in *Fig.* 6 is of the internal type made up of three separate shoes, pinned together to form, in effect, a continuous band. For lightness and accuracy of casting these shoes have been made of die cast aluminum. This has been entirely satisfactory in the case of the first two shoes for all machines and for all of the shoes for the lighter machines.

However, the heavy loads to which the dead end is subjected, in the case of the larger machines, has made it advisable to use a ferrous casting for the dead end shoe. Malleable iron has been chosen in this latter case as it possesses the ability to be cast in light sections, is of high strength, is resistant to shock and fatigue, and is easily straightened and machined.

Sculptural Methods Aid Engineers in External Design

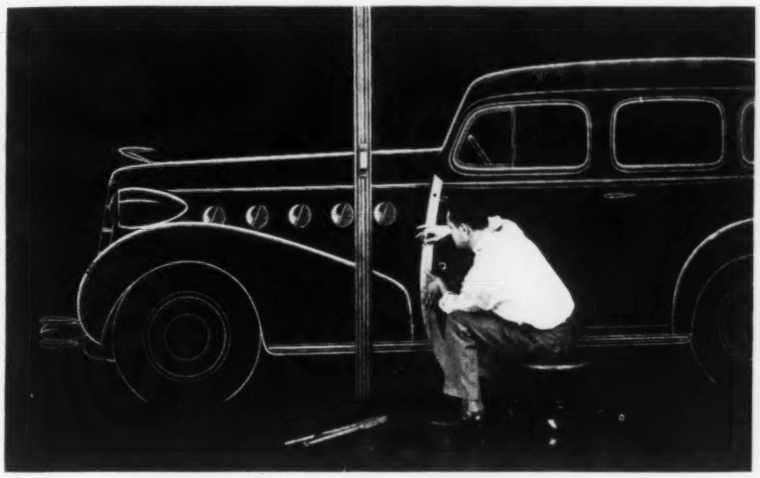


Fig. 1—*Blackboard sketch assists in visualizing design before modeling*

By Harold B. Veith

NO LONGER are designers relying upon the picture in their mind's eye as a criterion of what a machine will look like when it comes out of the shop. Too often nature plays tricks and even a small factor like a highlight in the wrong place may be the unmaking of an otherwise perfectly good design. So, to observe precisely how the machine will appear when finished, a model is made. Patterns, dies, etc., are too costly to take the risk that the completed design will not possess the proper sales qualifications.

Eye Appeal Is Sales Appeal

Probably the greatest single force behind this utilization of models is the present day trend toward improved appearance. In another day not long ago it was safe enough to depend on the engineering drawings alone to portray some idea of the appearance of a unit that was in the process of creation on the board. Sales then did not depend so much on pleasing lines. Today, however, the first question asked of the designer by the sales staff is, "How will it look when it's finished?" The model offers the only practical answer. It is impossible to show in two dimensions how a curved surface will actually appear.

One of the pioneers in the use of models is the automotive industry, and it is especially interesting to observe the effectiveness with which

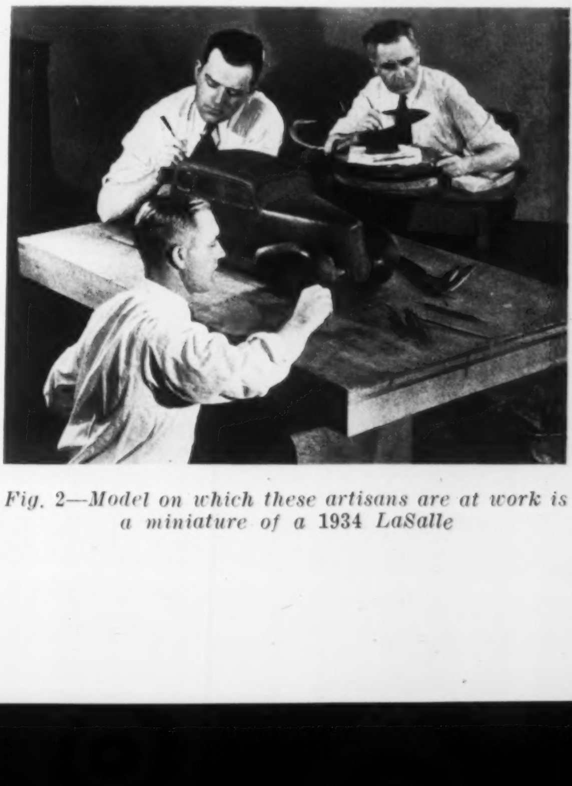


Fig. 2—Model on which these artisans are at work is a miniature of a 1934 LaSalle

automobile engineers have used models in the design of their streamline cars. LaSalle's activity in the use of models, *Figs.* 1, 2 and 3, is a case in point. Methods employed in this field might well be taken as a basis on which any industry could work in adopting this procedure for design departments.

Fig. 3—*Full-size wood model of the* 1934 *LaSalle was one of the final steps in its conception*

The first step carried out by another prominent automobile builder, Chrysler Corp., is a similar blackboard drawing, the layout of course taking into consideration the mechanical requirements of the car. When the sketch has been worked out to meet the approval of all those concerned, a clay model is built to the actual dimensions of the prospective auto. Upon a wooden framework which simulates the general contour of the blackboard sketch, artisans spread approximately two inches of clay. This thickness allows sufficient material for cutting away to make any desirable changes in the contour of the body.

Smallest Details Worked in Clay

With this actual size model the clay craftsmen set out to duplicate in three dimensions the sketch which previously has been drawn on the blackboard. Using specially fashioned tools to work the clay, they reproduce the smallest details, even to the door hinges. Extruding devices provide them with long strips of variously-shaped material with which they imitate the beading, radiator grille and other appurtenances. In the hands of these modern sculptors the crude clay mass takes the shape of a finished car.

Now it is possible for the executive designer and his staff to judge the design from an appearance standpoint. Perhaps a corner will be shaved down here and more clay added there to obtain the proper proportions. But with this clay model there is an absence of highlights, an important consideration where long sweeping surfaces are concerned. Moreover, clay gives a heavy appearance. Consequently, a subsequent step in the evolution of the design is taken and work commences on a wood model.

Because the design is virtually approved with the completion of the clay model, the construction of the wooden replica moves along rapidly. Simultaneously the draftsmen work up full scale drawings on aluminum sheets, painted to take the ink. Aluminum is used to obviate shrinkage. The wood model is carried through the same general assembly operations as an actual car. A wooden radiator is installed, a grille made of metal added, glass inserted in the window frames, in fact it is difficult to distinguish it from a car directly off the assembly line when wheels and the finish have been placed on it.

Accuracy Most Essential

From the wood model Keller forms or templates used in producing the dies for the body panels are made. These must check with the drawings on the aluminum sheets, which receive a coat of shellac upon completion to protect the inked lines. In other words the manufacturer has a double check before his Keller forms and drawings go out to the diemakers who in most cases are located at several different centers. Seldom are all dies made by the same organization. Therefore, it is doubly important that specifications be accurate. The Keller forms, moreover, are fitted together at the plant to make certain that they match up.

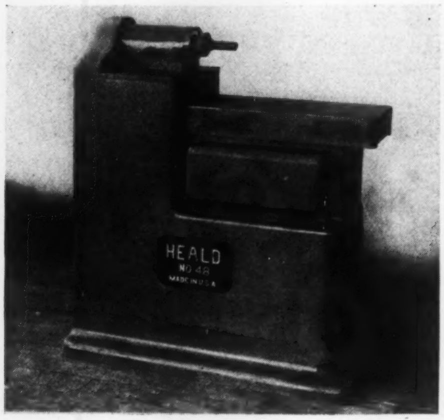


Fig. 4—*Wood models also are being employed by machine tool builders to study design from an appearance standpoint*

Another use of the wood model, particularly in designing transportation equipment, is its adaptability to wind tunnel tests. Automobile manufacturers for the past several years have used this method of arriving at the most effi-

(*Concluded on Page* 67)

Modern Parts + Design Ingenuity = Simpler Mechanisms

By C. L. Fitz
Engineer, Herman A. DeVry Inc.

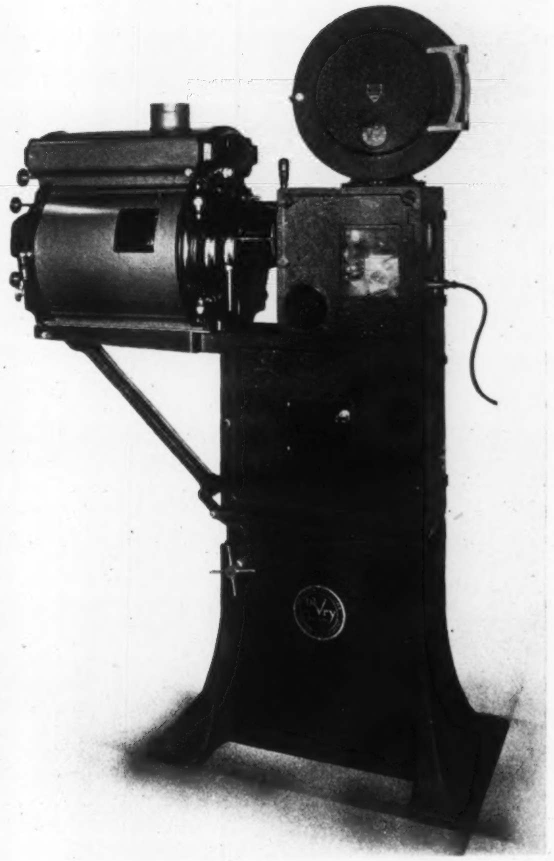


Fig. 1—Elimination of exterior mechanisms is made possible by more compact arrangement of operating parts in motion picture projector

MANY a machine which started out as a simple mechanism has, after a period of years, acquired the insidious habit of becoming more and more complicated. New uses for the machine are developed and new devices are "tacked on." New refinements in accomplishing the result are introduced, and a patch is fashioned to fit into the original with as little disturbance as possible. Additional duties are required by the user, and again an addition is added. Before long, the machine becomes a mass of complicated mechanisms. Each does its job, but there is a headache in store for anyone trying to fathom the involved operation or attempting to adjust the various devices. Such a condition existed in theater motion picture projectors. These machines had become cumbersome masses of cooperating devices; they had accumulated a number of unnecessary parts and the condition was greatly aggravated by the addition of sound mechanisms to the old silent machinery. It was at this point that Herman A. DeVry Inc., Chicago, decided to toss out the ordinary conception of what a projector should be like, begin all over again with the experience of past performance and knowledge of the results desired, and design a theater projector incorporating both sound and picture reproduction in a single machine; a design that would reduce the number of parts, noise, weight and bulk.

The first point in this redesign was the selection of a driving means. Motion picture projectors necessarily include a number of shafts and sprockets, and it is absolutely imperative that these shafts be synchonized. There are a number of methods by which this synchronization can be achieved, but when the sprockets are separated by more than a few inches, the specter of extra and probably unnecessary parts arises. Also, one of the sprockets was a part of a framing mechanism which had to be adjustable. Adjustments are quite usual in projectors as it is necessary that the picture be directly centered, or framed, in front of the aperture.

Considering these design requisites, a silent chain drive of ⅜-inch pitch was adopted for conveying power to all shafts. There are two of these chain drives, *Fig.* 3, one operating all of the shafts carrying film sprockets used in the reproduction of the film, and the other operating the winding reel and discharge mechanism. Power for the drives is received from a built-in

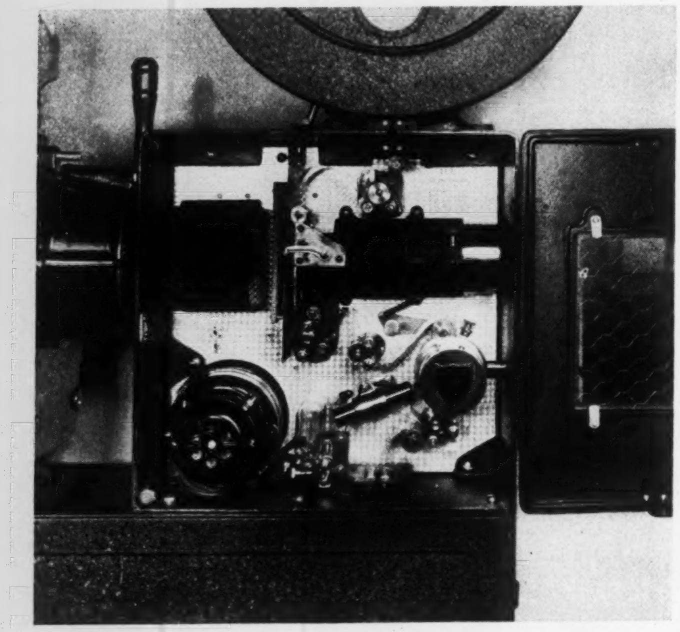


Fig. 2—Operating and photographic parts of projector are mounted on either side of a central plate

motor through a V-belt connected to the shutter shaft in the first drive circuit. A double V-belt is used, although one such belt would drive the machine, to insure constant power regardless of possible breakage. The second, or discharge, chain is directly connected to one of the shafts in the first circuit, insuring correct synchronization between the circuits. Tension in the chain is maintained by idlers mounted on arms which swing around a pivot. A knurled head screw forces these idlers tighter against the chain, or loosens the pressure.

With this method of driving quietness is insured, and the need for exact centers is eliminated, with a consequent saving in production costs, as the drive can be accomodated to slight differences in centers. Complicated mechanisms are not necessary at any point. Thus maintenance is greatly simplified and adjustments do not require the mechanical ability that might be necessitated by involved devices, an ability which operators might not possess.

Framing Is Simplified

Framing of the film has also been simplified. Instead of many co-operating parts, each of which disturbs or adjusts another whenever a picture must be framed, a simple device has been incorporated as a composite unit of the drive. With this mechanism, framing of a picture does not affect any part other than the ones which must necessarily be adjusted to accomplish the result. A hand lever, *A* in *Fig.* 3, is used by the operator to frame the picture. This lever cooperates with plate *B* on which the intermittent mechanism, the device which carries one section of the film at a time before the lens and holds it there temporarily, is mounted. Raising or lowering of this plate will bring the picture to an exact central position before the lens.

It is obvious that such a raising or lowering would introduce a condition of either extreme tension or inefficient looseness in the chain drive unless some provision were made to maintain proper chain tension. This is accomplished by the inclusion of two idlers in the drive, *C, Fig.* 3, one located at either side of the sprocket driving the shaft on which the intermittent mechanism is mounted. These sprockets are mounted on arms, hinged on the adjustment plate. Their shafts extend into cam grooves in the mounting plate which regulate the horizontal position of the idlers with respect to the driving sprocket. As the driving sprocket is moved above or below the central position, these idlers move away from center. Thus when a condition might be created that would require a longer length of chain to pass over the three sprockets, the driving sprocket and the two idlers, the idlers are adjusted by the cam grooves so that the length of chain remains constant.

Another innovation in this machine is the employment of a barrel type shutter, *Fig,* 4, as standard equipment. In previous designs a disk shutter cut off the illumination during the short interval that the intermittent mechanism was bringing another frame into position. This disk shutter moved across the film from one side to cut off the light. While this method was sat-

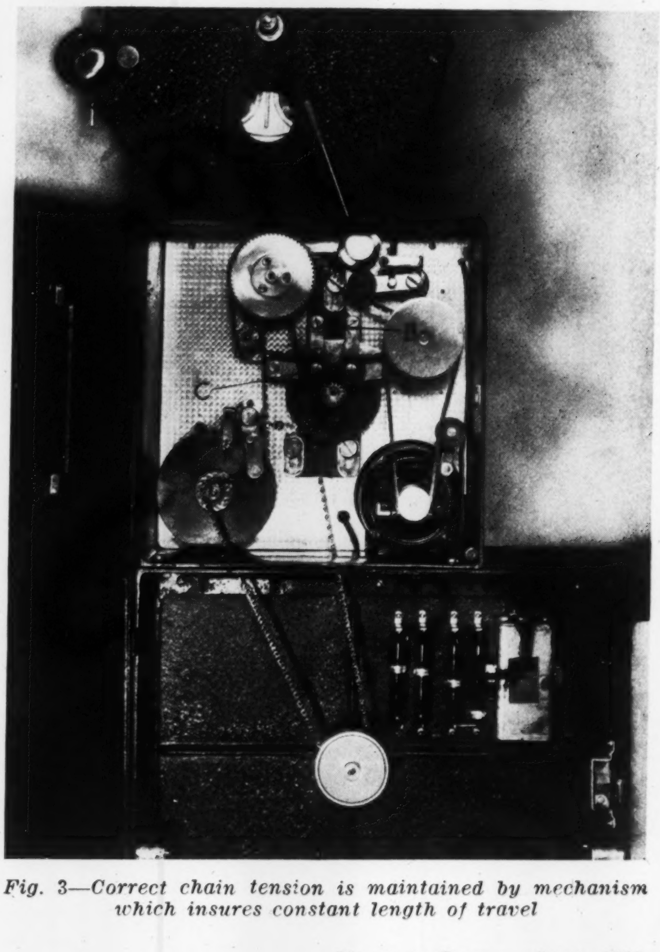


Fig. 3—Correct chain tension is maintained by mechanism which insures constant length of travel

isfactory, it was believed that a better method could be evolved. The barrel-type shutter adopted consists of a cylindrical part, through the center of which is provided an opening. When the picture is correctly framed, this central part is directly in line and allows the picture to be projected on the screen. At that moment when it is necessary to block out the illumination for progression of the next picture into position, the barrel shutter closes off the opening from both top and bottom, the forward upper edge coming down over the opening, and the back lower edge rising. Thus the closing and opening of the shutter is accomplished from two sides instead of one with a consequent more nearly instantaneous action.

In order to promote safety and to keep the heat of the film at as low a point as possible, the shutter was removed in the redesign from in front of the lens, the position formerly occupied, to the rear of the film. In fact, it is the last piece of mechanism in the machine, and its continual blocking of the light source serves to reduce the amount of heat on the film, while the shutter has a fan action which speeds cooling.

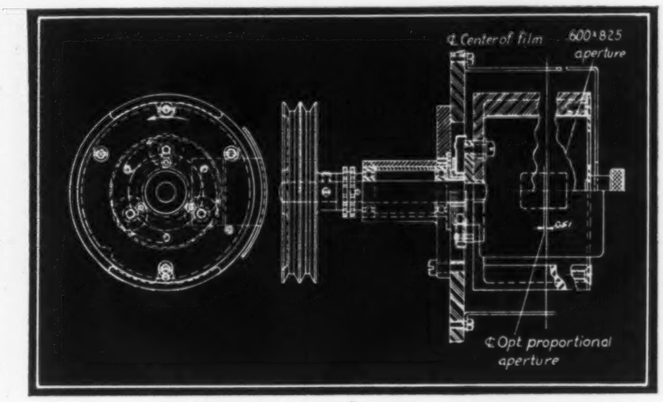


Fig. 4—Providing more instantaneous shutting off of light, barrel-type shutter also cools film

Due to the addition of sound, the speed of the film is increased from 60 to 90 feet per minute, putting a greater strain on the intermittent than was necessary with silent films, so that on this particular device there is a greater necessity than before for an unusual degree of accuracy in all parts of the intermittent unit. The intermittent movement is of the well-known geneva cross type, but, in order to avoid bending of the projections carrying the slots, this geneva wheel is reinforced by offset webs. It is made of tool steel, hardened, ground and lapped to a tolerance of less than 0.0005.

Naturally, with such attention given to mechanical detail, it also was advisable to consider the appearance of the machine. The improvement over previous models is obvious from *Fig.* 1. Balanced design permits a more streamline appearance, all usual projecting parts being encased in a dust-proof metal case.

Parts Redesign Required for Higher Speeds

By J. Edward Schipper

WHEN we look at the specification tables as published in the trade papers for the years of 1939 and 1940 we are going to note automobile engines which reach their peak horsepower at 5000 R.P.M., or possibly higher. So many engineers are convinced of that fact that it is interesting to study just what must come about to make these higher speeds possible.

It is certain that some of the practices which are almost universal today will have to be eliminated. Some new things which at the present time are merely laboratory developments will have to come into general use and no doubt along with these new engines will come changes in clutch and transmission practice as a result.

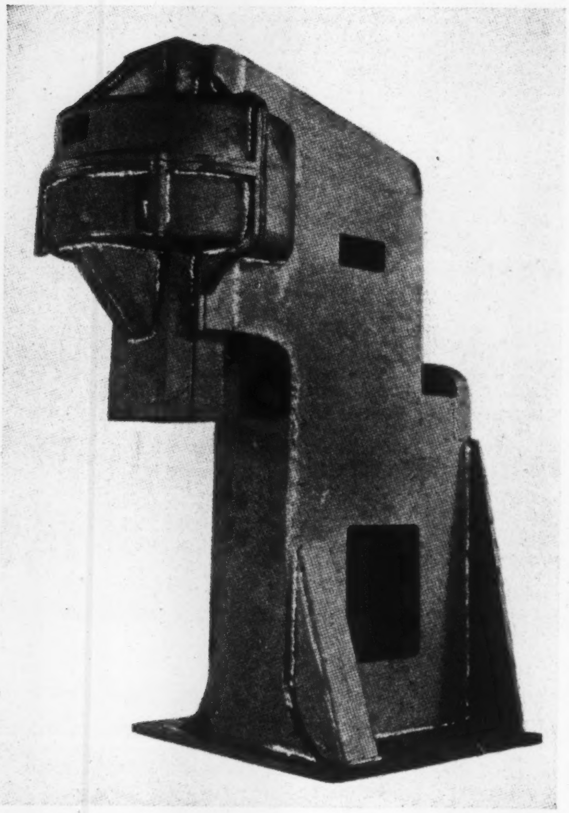
It is quite certain that the day will arrive when the poppet valve engine will no longer exist for high speed passenger cars. It is amazing to many engineers that it has been possible to design a poppet valve system which permits of the speeds attained today, but it is certain that we are reaching the top limit. To put this another way, the engineering world is crying for a satisfactory rotary valve system which will not be subject to the ills that have beset previous rotary valves, particularly as regards overheating.

Bearing Troubles Eliminated

It is well within the realm of possibility that the aluminum connecting rod will return as speeds go up. At least one manufacturer, Nash, has found that with the use of the aluminum connecting rod bearing troubles are practically eliminated. It is certain that the loads on the bearings are greatly reduced with the light rod and present knowledge of the material has removed any doubt as to its suitability for connecting rods. As far as the bearings are concerned, the new cadmium and copper-lead development will permit much greater unit loads than is possible with babbitt, consequently this will not be a serious problem.

Heavier crankshafts may be required as engine speeds go up in order to bring the critical period of the shaft up beyond the operating point. Some of our crankshafts at the present time are being worked close to their critical point at the peak. With increased crankshaft diameter we have increased linear speed at the bearing surfaces, which in turn imposes higher duty on the oiling system. However, improved lubricants plus better oil distributing systems, racing practice, have also eliminated any of the great uncertainties at this particular point.

Does Welding Code for Machinery Fill Industry's Needs?



Welded machine frames such as this are covered by the proposed code

RECENTLY issued by the American Welding society is the tentative code for Fusion Welding and Flame Cutting in Machinery Construction. Machinery for which the code, available through the Society, is intended is typified by the unit shown in the accompanying illustration.

The code deals with base metal, filler metal, heat treatment and permissible unit stress. It also includes sections on gas cutting, qualification tests for operators and precautions to be observed. Because of limited space a brief summary only can be made of the copious and profusely illustrated material.

In general the code refers to carbon steels containing not more than 0.30 per cent carbon with a word of caution given on welding of higher carbon steels and special alloys. Section seven on gas cutting sets forth that gas-cut edges shall be smooth and regular in contour. Gas cutting may be used in the preparation of base metal parts for welding, provided the edges so cut are left free from excessive scale. Gas-cut edges at critical contours shall be ground or machined to eliminate notches.

Suggestions Deserve Consideration

Engineers, after they have studied the code thoroughly, might take under consideration the following suggestions, made by a prominent designer:

1. It should be recognized that such codes as this have both advantages and disadvantages from the machinery manufacturer's point of view. Advantages lie in the direction of curbing the price cutter who does it by cutting the corners on safety and length of service life. Disadvantage lies in the fact that the code is necessarily written on theoretical grounds and does not take into account the vast amount of experience upon which no data has ever been collected. When a welded assembly is built and guaranteed by a reputable manufacturer it would seem that the sales contract covers legal responsibility to an adequate degree so long as the safety of the public is not involved.

2. On the matter of heat treatment, the first paragraph of section 5 of the proposed code seems to call for more stress relieving than is in use at the present time. Automobile frames are being made rigid by use of arc welding, and other applications of the same process are used in which the assembly is not stress relieved. The same is true in road-building machinery, steel mill equipment, mining machinery. The welds in these classes of machinery are subjected to severe impact loading and the safety and performance of the parts depend on welds, yet they are not now being stress relieved.

3. Permissible unit stresses. Provision for radiographing welds with the same freedom from defects as required by A.S.M.E. boiler code is impractical to carry out in the case of fillet welds. Radiography in the A.S.M.E. code applies only to butt welds.

4. It would be desirable to have the term "weldability," as applied to metals for machine construction, defined with more precision.

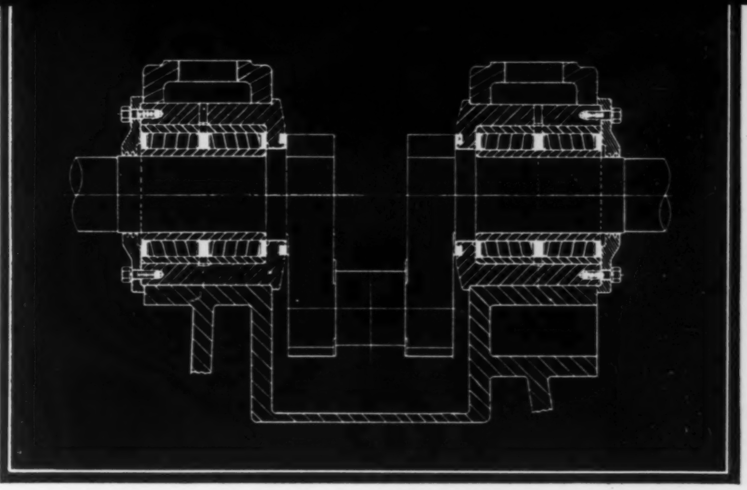


Fig. 1—Enjoying ideal operating conditions, design can be conservative

Service Factors Define Bearing Needs Exactly

By J. L. Haynes

Division Engineer, Hyatt Roller Bearing Co.

ENGINEERS who have occasion to study problems connected with the application of antifriction bearings to various types of machinery soon learn that there are certain fundamental principles relating to antifriction bearings and their use which are common to all work no matter what may be the type of application or the industry. We also learn that there are, for every different industry, certain practical considerations which must be kept constantly in mind when studying the selection of the most suitable bearing for any particular job.

It is impractical for us here to go into details for the many different machines that use the various types of antifriction bearings, but we can say, in general, that the chief factors which must be properly evaluated for any type of machinery will fall into one or more of the following classifications:

Is the machine required to have many years of life or relatively few?

Is the operation required to be nearly continuous or relatively intermittent?

What degree of mechanical refinement is involved for the machine as a whole? That is, is it in the class with a machine tool or in the class with a wheelbarrow?

What degree of careful attention or of abuse does the machine receive at the hands of the men who use it?

Is the machine in question one that must be extremely safe from the standpoint of the high cost involved by interrupted service?

Is the machine one in which human life is endangered by any mechanical failure?

What are the facilities for repairs or replacements in the field? This also usually involves the element of time.

What are the physical conditions in the field? Does the machine operate out of doors or in a building? It is subjected to high temperature or low temperature? Is it exposed to dirt, mud and water, or is it in a clean place?

It is not necessary to extend this list of economic and physical factors to emphasize their importance in the final design of the bearings for any machine.

The purely technical factors that are involved in the general work of antifriction bearing application design are usually easy to deal with. Calculation of bearing loads and speeds needs no discussion, and the selection of proper size shafting is usually the responsibility of the engineer designing the machine, so that the bearing design seldom enters as a factor to influence the size of shaft except to the amount of change in diameter required to fit the nearest standard bearing dimension.

Proper provision for bearing alignment is

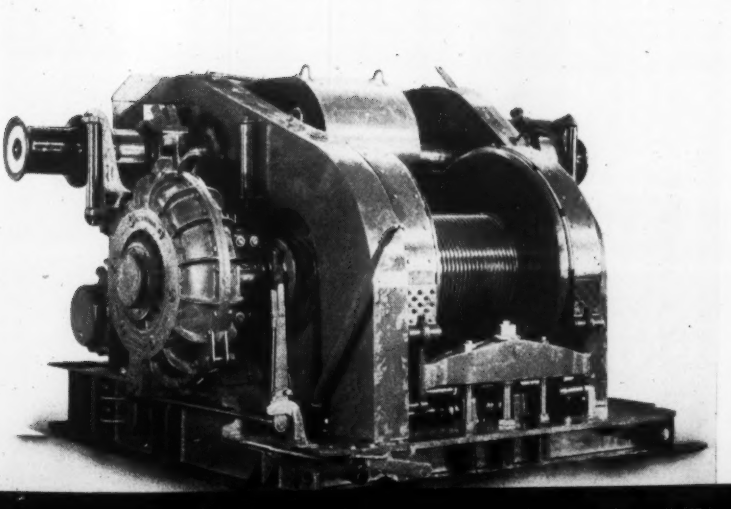


Fig. 2—Liberally proportioned roller bearings insure long life

assured by the method of machining in many jobs, while for installation where the main supporting members are not rigidly held, special self-aligning boxes are usually required.

There are other considerations, such as shock load and impact load, that may be regarded as technical factors that can be analyzed mathematically, and there also is often the design problem of accommodating a bearing to very limited space.

For most types of machinery, after we have analyzed the bearing problems accurately to our formulas, etc., we lay aside the pencil and paper and study the general problem in the light of the eight broad general factors listed in the foregoing.

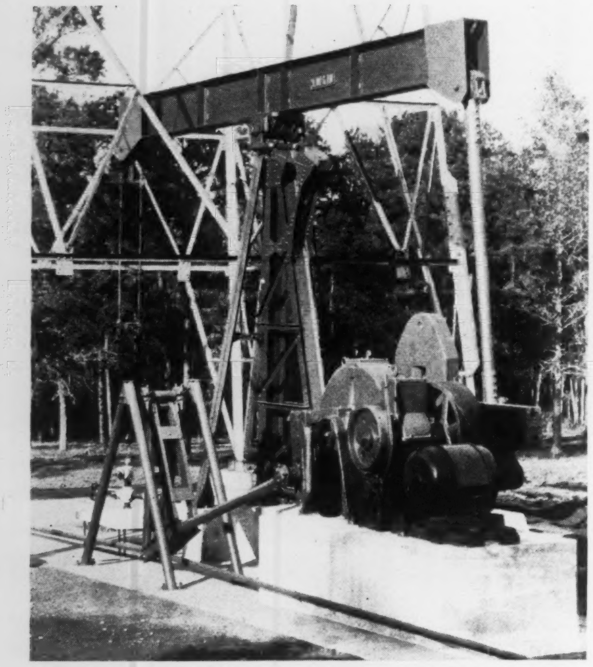


Fig. 3—Special alloy steel rollers resist forces on severe applications of this type

Study of a class of equipment with as great variety as the many machines used in the petroleum industry, as an example, shows that there are some that require the viewpoint of maximum refinement for long life, great reliability, operation without attention and maximum safety. There are other types of units where the service may be so intermittent that the cost of bearings and their mountings must be reduced to the point where maximum bearing life is impossible but, nevertheless, the installation must be reliable and safe for the type of service involved.

Fig. 1 shows a pumping engine mounting which is an excellent example of a roller bearing installation where all of the thought is on the conservative side so as to insure long life, reliability, and carefree operation. The operating conditions here are as nearly ideal as possible from the standpoint of loads, speed, cleanliness, good lubrication and, in fact, all conditions are right to enable a high grade bearing of liberal size to pay for itself during a fraction of the total life of the engine.

Fig. 2 shows a draw works which is equipped with liberally proportioned roller bearings. This design has been extremely successful for a number of years due to being carefully designed to suit severe service conditions. The outstanding requirements that must be considered in connection with bearings for a draw works are heavy loads, suddenly applied, uncertain alignment of bearings, operation out of doors, and general rough handling, both during drilling and during transportation.

The bearings applied to both the engine and the draw works design have case-hardened inner and outer races and separable roller assemblies with special alloy steel rollers. These rollers are hardened, tempered and ground to close tolerances to insure accuracy in bearing fits. The special helical-wound form of these rollers and the type of steel used gives a certain flexibility and great resistance to fatigue under severe loading.

Fig. 3 is an illustration of familiar equipment that has used this type of bearing for years, with good success.

Conditions which present great difficulty in any type of equipment affecting roller bearing installation and operation are space limitation and the presence of dirt, mud and water. Bad dirt and water conditions alone are not so difficult because, where there is space for a good seal to protect the bearing enclosure, good attention to lubrication will help keep the bearing free from foreign matter so that satisfactory service and life may be obtained.

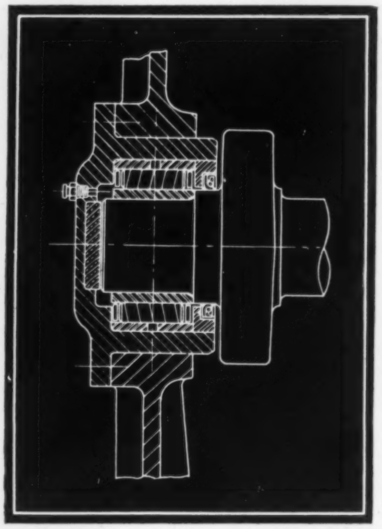


Fig. 4—Seals exclude any foreign matter that might be in the oil

A slush pump is typical of the class of service in which the bearing requirements are not especially difficult from the standpoints of load, speed, space available, etc., but where careful sealing of all bearings is needed. The design in *Fig.* 4 shows the way in which seals are applied to exclude from the bearing enclosures any foreign matter that might be present in the oil in the crankcase of the pump, and each roller bearing is provided with individual grease lubrication.

The type of bearing problem that best exemplifies requirements of heavy load that must be carried in a small space is probably a traveling block or crown block. The chief restriction of space is bearing length. Therefore, the type or roller bearing that logically fits these requirements is one with a maximum amount of load capacity per unit of length.

Fig. 5 shows a recent design of traveling block, in which the maximum roller capacity for heavy loads is obtained in the minimum length of sheave consistent with due allowance for the tipping effect of some side pull by the line. The bearings used here have solid alloy steel rollers and races. Both the rollers and races are case hardened and accurately ground so that all rollers will receive their proper share of the load uniformly for the entire line of contact on the races. No cage or separator is used, thus enabling the maximum possible number of rollers to be used in the bearing. Alloy steel rings are inserted in suitable grooves provided in the races so as to keep the bearings together as one complete unit during handling for assembly or overhauling. A circumferential channel and holes are provided at the center of the inner race to enable the bearings to be lubricated through a hole in the shaft. Details are shown in *Fig.* 6.

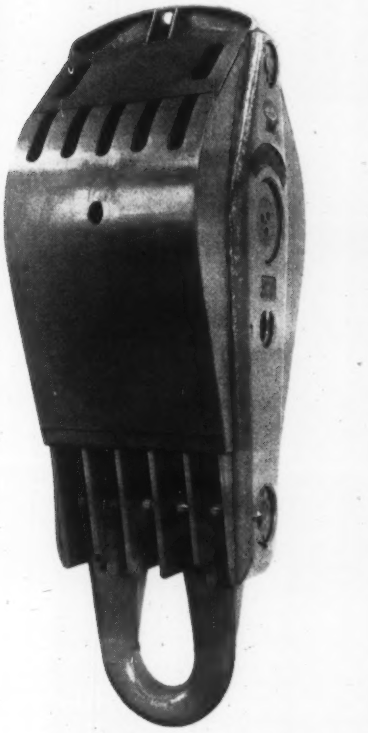


Fig. 5 — Uniform load on the rollers is necessary in applications where length is limited

A good example of a job where the roller bearing must carry a heavy load under continuous service with little attention to operation, and in which careful provision for poor alignment is required, is a pitman bearing on a pumping unit. *Fig.* 7 shows a pitman design with a double length bearing having two entirely separate sets of rollers with one pair of long races. The load capacity of such a bearing is high due to the fact that the self-aligning box insures that the load will be evenly distributed over the entire length of both sets of rollers.

The materials and design of this type of bearing are similar to the crown or traveling block bearing in *Fig.* 6, but for the pitman no such exact restriction is placed upon the permissible length of bearing, so we are able to take full advantage of the high load capacity of a double length bearing having two complete sets of solid rollers. This bearing has a removable inner race, and the separators or cages for the rollers always hold the rollers in place as one unit with the outer race when the assembly is being made. *Fig.* 8 shows clearly the general design for the Hy-Load solid roller bearing just described. A single row standard width bearing is illustrated but the same form of construction is used for wide series bearings like the sheave bearing in *Fig.* 6 and also the double width series, as for the pitman in *Fig.* 7.

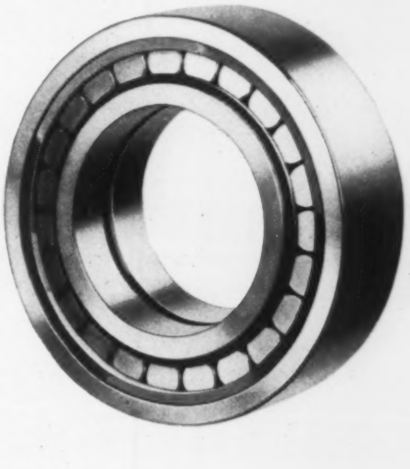


Fig. 6—Circumferential channel permits lubrication through the shaft

Power saving is usually difficult to determine for any particular job unless actual tests are run between two similar machines, one of which is equipped with plain bearings and one of which has roller bearings. This is seldom practical and often impossible to do. The amount of power dissipated in plain bearings is an extremely variable quantity depending upon many different factors. A rough check on the comparatively low power loss in a roller bearing is obtainable with the following formula:

$$\text{Horsepower loss} = \frac{\pi \times D \times L \times (R.P.M.) \times 0.0016}{33{,}000 \times 12} = \frac{D \times L \times (R.P.M)}{79{,}000{,}000}$$

where

D = outside diameter of the inner race, inches
L = bearing load, pounds
0.0016 is a liberal allowance for coefficient of rolling friction

We shall not discuss the general problem of

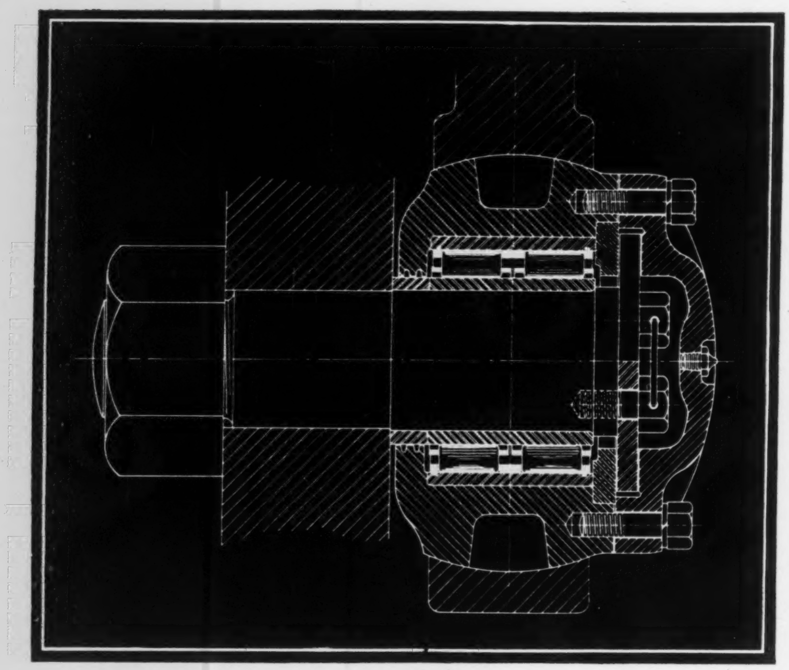


Fig. 7—Self-aligning box insures that the load will be evenly distributed over the entire length of both sets of rollers

roller bearing lubrication in much detail as that is a subject suitable for discussion as an independent article, but we shall attempt to answer a few common questions in connection with lubrication.

Designers often ask how often a certain bearing should be lubricated, having in mind generally that the more severe the bearing service the more frequently it will need attention. The conditions that govern frequency of lubrication are generally the type of bearing mounting and the tightness of the seal because the performance of a roller bearing will be uniformly satisfactory for a long time with no change of lubricant if it can be kept clean and free from loss by leakage.

Grease May Act as Seal

For practical reasons of cost and simplicity of manufacture, roller bearings are often applied to jobs where no seal is provided other than a small clearance space between the housing cover and the shaft. In this type of mounting a medium grade of grease should be used which will require renewal quite often as the service performed by the grease will be largely to seal the bearing housing against dirt and water by slowly working out around the shaft through the small clearance space, thus tending to carry away any foreign matter.

Oils, in general, are better than greases for roller bearing lubrication, but this fact is not entirely due to any causes to be deduced by highly technical analysis. Where oil is used and the housing for the bearings is well sealed and has an oil chamber or some liberal clearance spaces below the bearing, the best bearing performance may be obtained because the oil continually washes down the races and rollers, and any foreign matter that might have worked into the housing will tend to settle out of the oil, thus keeping the bearing clean and resulting in maximum useful life.

Where grease is used, any worn particles or dirt in the bearing will become mixed with the grease, making a slow-acting lapping compound which eventually causes bearing wear.

Another disadvantage to the use of greases is the tendency for the bearings to run warmer at fairly high speeds than when using oil. This is caused by the fact that the churning action, especially for large bearings, naturally produces more heat when operated with greases as these are thick as compared to oils. However, this consideration makes very little difference regarding the use of greases for oil field equipment as the speeds encountered are generally comparatively slow, and in many types of service operation is intermittent.

Even though oil is to be preferred, grease is most commonly used for roller bearings because of its ready adaptation to inexpensive types of bearing mountings. When grease is used, fairly frequent application of fresh lubricant is desirable in order to promote cleanliness of the roller bearing because it is felt that for all classes of machinery using antifriction bearings more premature replacements are necessitated by dirt or other foreign matter entering the housings than are caused by any other single influence.

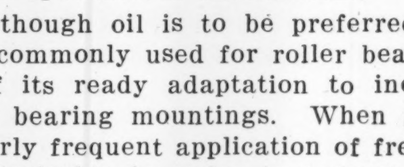


Fig. 8—Double length bearing has two complete sets of rollers

New Machines Indicate Design Trends

INCORRECT lubrication or the entire lack of lubrication will do more to destroy the good-will of the machine user than any other factor wholly under the control of the purchaser. Realization of this fact by the designer is reflected in the more frequent inclusion of nameplates on the machine specifying exactly the kind and grade of lubricant to be applied. By this means, the designer can be more nearly certain that his machine will receive the kind of lubrication which will insure the best service. Engineers have been assisted in this work by the research of the oil companies, and by the charts which these organizations have prepared to assist in the choice of correct lubrication.

Machines recently announced in addition to those on the next two pages include the following arranged by fields of application:

Air Conditioning

Industrial Units,
  Frigidaire Corp.,
  Dayton, O.
Room Cooler,
  Corozone Co.,
  Cleveland.
Humidifier,
  Bryant Heater Co.,
  Cleveland.

Brewery

Ozone Machine,
  Wiliam J. Lohman Inc.,
  New York.

Construction

Portable Pump,
  Jaeger Machine Co.,
  Columbus, O.
Three Wheel Elevating Grader,
  Austin-Western Road Machinery Co.,
  Aurora, Ill.

Domestic

Ironer,
  Hurley Machine Co.,
  Chicago.
Vibrator,
  Hamilton Beach Co.,
  Racine, Wis.
Washing Machine,
  Norge Corp.,
  Detroit.
Electric Clocks,
  Pennwood Co.,
  Pittsburgh.

Food

Meat Cutter,
  Vaughn Co.,
  Chicago.

Foundry

Blast Cleaning Mill,
  W. W. Sly Mfg. Co.,
  Cleveland.
Sand Screening Equipment,
  Newman Brothers Co.,
  Cincinnati.

Industrial

Gasoline Tractor,
  W. F. Hebard & Co.,
  Chicago.
Time Recorder,
  Simplex Time Recorder Co.,
  Gardner, Mass.

Metalworking

Quick Return Carbo-Lathe,
  Porter-Cable Machine Co.,
  Syracuse, N. Y.
Combination Cut-Off Machine and Grinder,
  Cincinnati Electrical Tool Co.,
  Cincinnati.
Electro-Hydraulic Borer,
  B. M. Root Co.,
  York, Pa.
Double End Bench Grinder,
  Hisey-Wolf Machine Co.,
  Cincinnati.
Multiple Punch,
  Williams, White & Co.,
  Moline, Ill.
Tapping Machines,
  Armstrong-Blum Mfg. Co.,
  Chicago.
Solid Frame Forging Press,
  Ajax Mfg. Co.,
  Euclid, O.
Rotary Surface Grinder,
  Hanchett Mfg. Co.,
  Big Rapids, Mich.

Mining

Diesel Locomotive,
  Ruth Co.,
  Denver.

Municipal

Sludge Pump,
  Novo Engine Co.,
  Lansing, Mich.

Paper

Two Direction Creping Machine,
  Cannard Co.,
  Green Bay, Wis.
Log Barker,
  Fibre Making Processes Inc.,
  Chicago.

Railway

Gang Car,
  Fairmont Railway Motors Inc.,
  Fairmont, Minn.

Refrigeration

Commercial Condensing Units,
  Westinghouse Electric & Mfg. Co.,
  East Pittsburgh, Pa.

Rubber

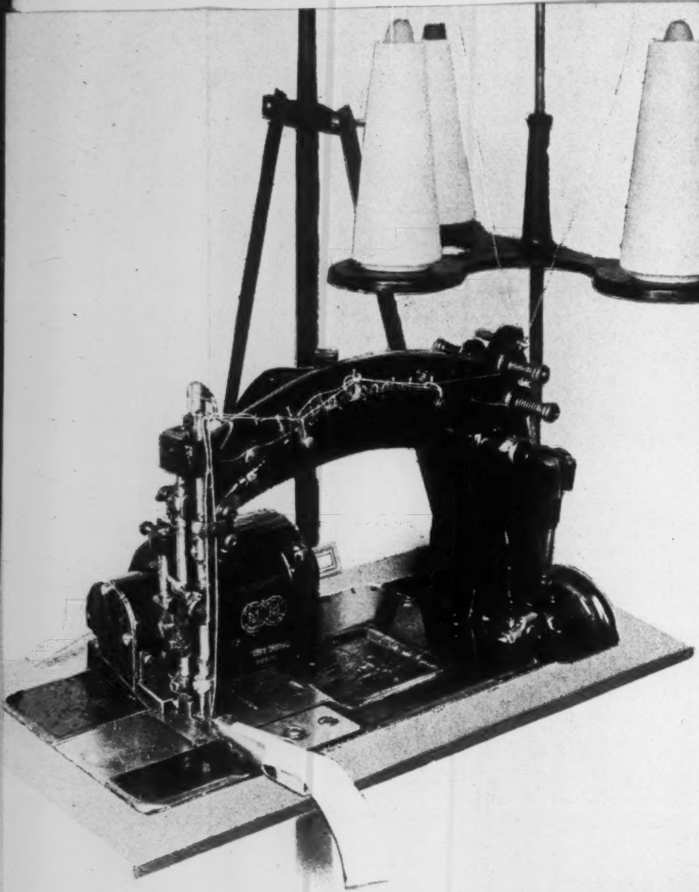
Convertible Laboratory Plasticator,
  Farrel Birmingham Co., Inc.,
  Ansonia, Conn.

Textile

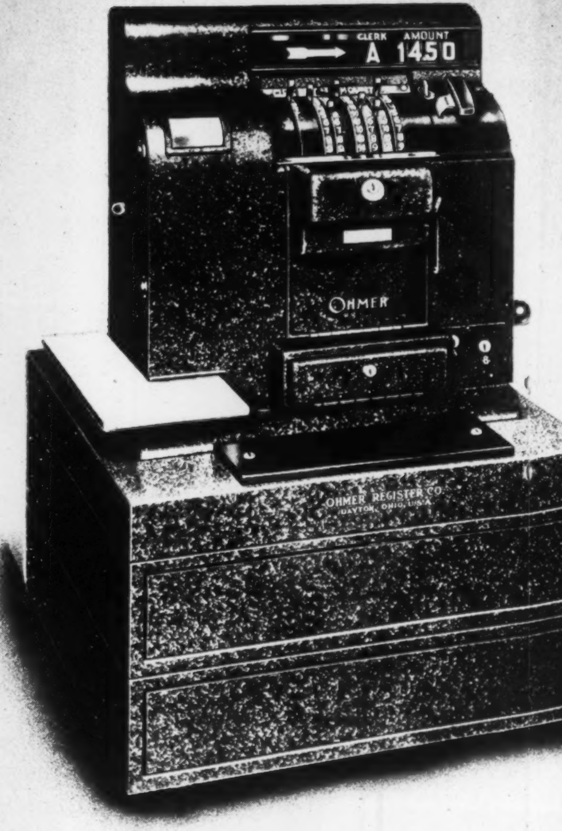
Spooling Machines,
  Fidelity Machine Co.,
  Philadelphia.
Automatic Length Cutting Machine,
  F. A. Firsching Inc.,
  Utica, N. Y.
Cone Winder,
  Universal Winding Machine Co.,
  Boston.
Knot Tying Winder,
  Abbott Machine Co.,
  Wilton, N. H.
Silk and Rayon Loom,
  Crompton & Knowles Loom Works,
  Worcester, Mass.
Inspecting Machine,
  Peerless Textile Machinery Co.,
  New York.

Welding

Commercial Welder,
  Lincoln Electric Co.,
  Cleveland.

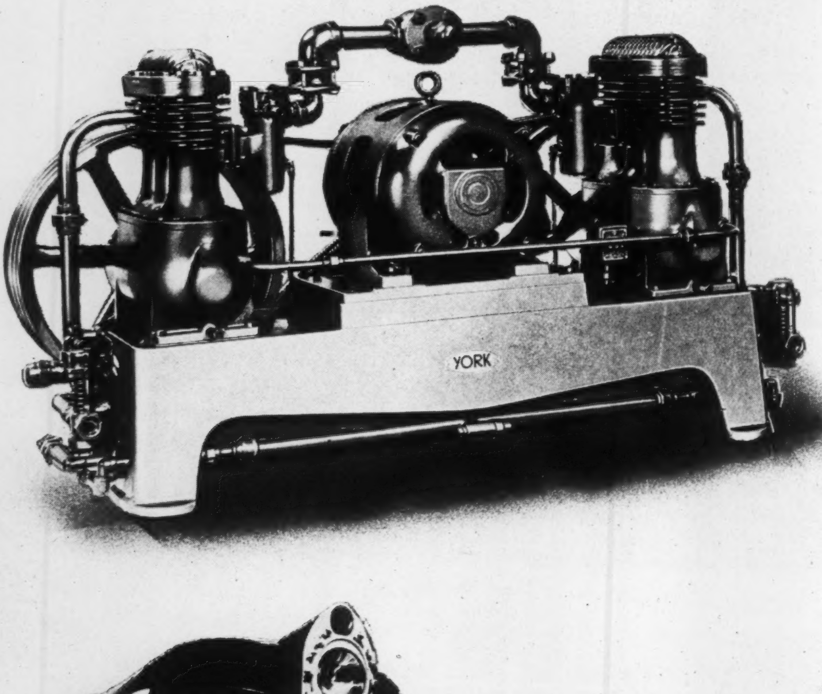


SIMULTANEOUS printing from two banks of type wheels is possible on as many as six records in Ohmer cash register, right. The grand totalizer is designed to be positive in its accumulating and is constructed of parts made largely of special alloy steel. The entire clerk locking mechanism is mounted in a single zinc die cast block. Each counter is of the reset type. Special bearing bronze is specified for all shaft bearings.



FIDELITY belt loop cutter, left, makes use of an improved ball ratchet drive for the measuring feed roll and a quick acting spring plunger mechanism to operate the scissor-type shears intermittently while the product feeds continuously. The cutter is automatically synchronized to the sewing machine.

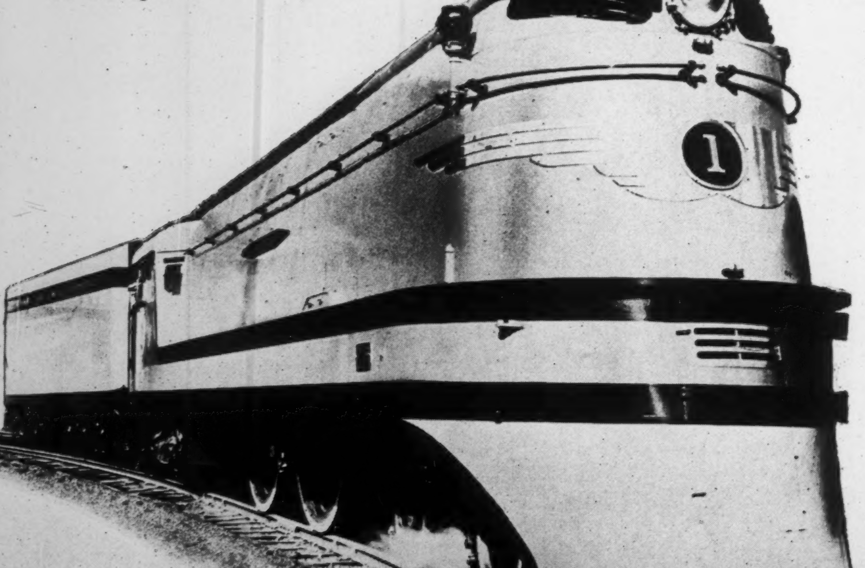
ELECTRIC furnace nickel iron cylinders, crankcase and pistons are specified for new York condensing units, right, to combat the action of Freon. The motor mounted in the center is connected by V-belts to two identical compressors.

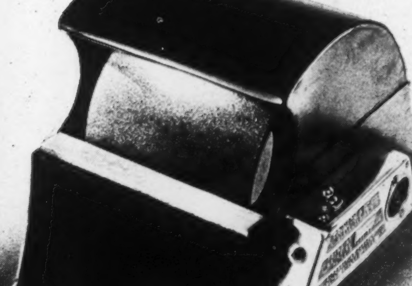


Design F
in New M

A Pictorial Presentation
from the Standp

THREE major factors, load, speed and horsepower were considered in the design of the new steam locomotive of American Locomotive Co., below. Streamlining was curtailed to preserve the thrill a spectator gets from a steam locomotive at full speed.





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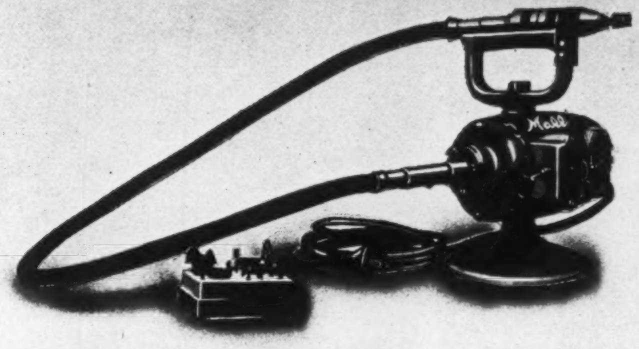
OUTER rings of the motor, on which abrasive and polishing sheets are mounted rotate in portable Trimson machine, above, while the inner rings are stationary. The motor is dust proof and dynamically balanced.



BALL BEARING mounted throughout for long wear and vibration-free operation, the Mall high speed flexible shaft grinder, above, weighs but thirteen pounds. An all aluminum frame used with the universal-type motor aids in achieving this weight reduction. Free speed of the motor is 20,000 revolutions per minute. The shaft is made of high grade, high carbon hard drawn piano wire and wound solid to the center.

Ditto
Ditto

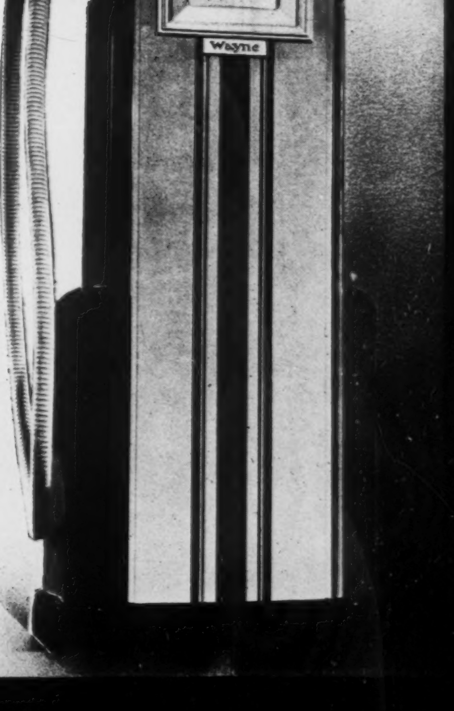
FOOT PEDALS control drum movement and advancing of the roll on new motor-driven Ditto machine, right. Noise is eliminated by the use of rubber rollers for contacting cams which control movable parts of the feed unit. Many of the parts are constructed of aluminum alloys which are given an anodic treatment. All operating parts are compactly assembled in a cabinet finished in green lacquer. Oilite bushings are used throughout.

n Features
v Machines

ntation of Recent Machinery
Standpoint of Design.

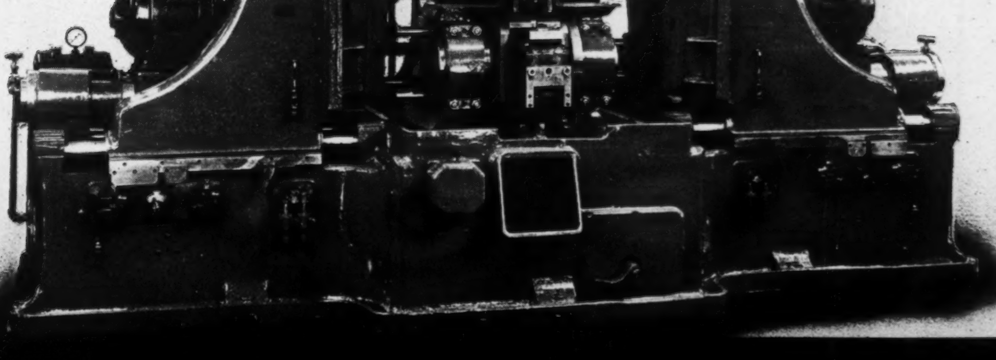
ELECTROMATIC
INTERNATIONAL BUSINESS MACHINES CORPORATION
ELECTROMATIC TYPEWRITERS DIVISION

A VAPOR PROOF and explosion proof motor, adjustably mounted to compensate for tightening V-belt, is used on Wayne gasoline pump, below. The rotary pump used has six blades for long life. An efficient air separator is standard equipment. Appearance design by Van Doren & Rideout.



TOOLS run in hardened guide bushings on Hammond three-way hydraulic drilling and reaming machine, right. Guide bars on the horizontal heads register with hardened bushings in the turret before the tools enter. After loading, and when the turret has moved through 90 degrees, a lock bolt snaps into engagement and automatically starts the three heads forward.

CONTROLLED so that it does not vary in speed with fluctuations in the electric current, the rubber-mounted motor in new Electromatic typewriter, above, can be used on either direct or alternating current. A governor is provided to prevent excessive carriage speed on long tabular jumps. It is possible for the operator to perform all typing operations without removing the hands from the keyboard. All operations except marginal release are performed electrically.



MACHINE DESIGN

It Would Take More Than a Depression To Stop Engineering Development

NO FULL-BLOODED engineer could read of the NORMANDIE and QUEEN MARY, the two greatest liners afloat, without a thrill of pride in his profession. Each of them 20,000 gross tons heavier than the largest ships in service, they not only can claim the laurels in regard to size, but also for up-to-the minute mechanical equipment. Four days to cross the Atlantic! Not as fast, certainly, as Lindberg's solo flight of eight years ago, but transportation of 3000 souls instead of one!

Both of these shipbuilding projects went ahead with government aid, French and British respectively. Or the approximately thirty million dollars equivalent foreign currency involved in the construction of the QUEEN MARY the British government loaned no less than fifteen million besides setting other sums aside for working capital. That's "relief" with a vengeance, but the result is a concrete example of outstanding engineering development in machinery—for after all, what is a ship if not a machine?

Such developments here are expected to go forward under private enterprise. So they are going forward, in the automotive and railroad industries—to cite more instances within the transportation field. And since NRA has just been declared invalid, who knows but what the consequent easing of pressure on manufacturers may result in such startling changes in tempo that we will be able to regain and maintain our industrial leadership in other lines?

It is early yet to forecast, but designers would do well to keep in mind the boom days ahead—with the ever-increasing need for more and better machinery in the same category as the NORMANDIE and QUEEN MARY.

• • •

Ideas in Materials

INCLUDED among the information on materials in a recent issue of MACHINE DESIGN was an item on the finishing and use of steel sheets. Though not in a prominent position in the journal, inquiry after inquiry rolled in from readers requesting additional details.

Better proof of interest could not be desired—or a more clear indication of the type of data for which readers are looking. It augers well for design of machinery that so great a number of engineers are ferreting out items and ideas that have an immediate or a potential value to them in their work.

Information of the type given is not commonly available; yet in order to keep readers up-to-date such items must continuously be located and written up by technical magazines. For—to the reader—"an idea in the head is worth two in the ash can!"

PROFESSIONAL VIEWPOINTS

Machine Design Welcomes Letters Suitable for Publication

Solves Shaft and Bearing Problems

To the Editor:

THE NOMOGRAM shown on page 42 will probably be of interest to your readers as it is of a universal type upon which formulas involving products, powers and roots may be laid. It is the same as that in the April issue on page 42 on which a different formula was laid.

The upper index lines show how the uniformity of load on long shafting effects the permissible horsepower to be transmitted. The formula is reduced from that given in Marks' Handbook, and G, the torsional elastic modulus, is taken as 12,000,000 for all steels. The chart shows the allowable twist in minutes per foot of shaft for the three load conditions there stated. Each computation requires two index lines. In all three computations, the index lines are seen to pass through $n = 250$ on the Z scale, and through the fourth power of $d = 4$ on the V scale, d^4 being obtained on V by connecting 4 on both the X and the U scales.

The lower index lines show the design of a needle bearing simplified from a formula given by K. L. Herrmann which is shown and explained on the chart. Each index line or secant cuts 3 scales, the values on any two determining the line. To find W, the lines should be drawn in the numerical order marked. The nomogram will, of course, solve for any other quantity, in which case the order will be different.

—CARL P. NACHOD,
Nachod & U. S. Signal Co.

Stresses Importance of Yield Point

To the Editor:

WITH reference to P. D. Forbes' excellent article, "Yield Point Is Paramount," on page 24 of the May issue of MACHINE DESIGN, or more correctly, with reference to the importance of the yield points of materials—it may interest your readers to know that in writing the specifications for a rather large class of machinery we have for nearly two years been referring the working stresses to the yield points. In cases where the usual safety factor of five would be suitable, giving a permissible stress of 12,000 pounds per square inch for 60,000 pounds per square inch steel, we are limiting the working stress to 40 per cent of the yield point, so that for a steel of 120,000 pounds per square inch ultimate strength and 105,000 pounds per square inch yield point, the permissible stress becomes 42,000 pounds per square inch, as compared to the 24,000 pounds per square inch that would be obtained if a safety factor of five were applied in the ordinary manner. For cases where a factor of safety of more than five would ordinarily be used, it is our practice to limit the working stress to one-third the yield point, or less, as the conditions may demand.

It can readily be seen that by thus taking advantage of the much higher ratio of the yield point to the ultimate strength found in the stronger alloy steels, an appreciably lighter construction results than if the older method of determining the working stresses were used—and lightness of construction is, in many cases, second in importance only to safety and proper functioning of the machine.

—CLYDE HEARNE,
Brooklyn, N. Y.

Streamlined into Commonness?

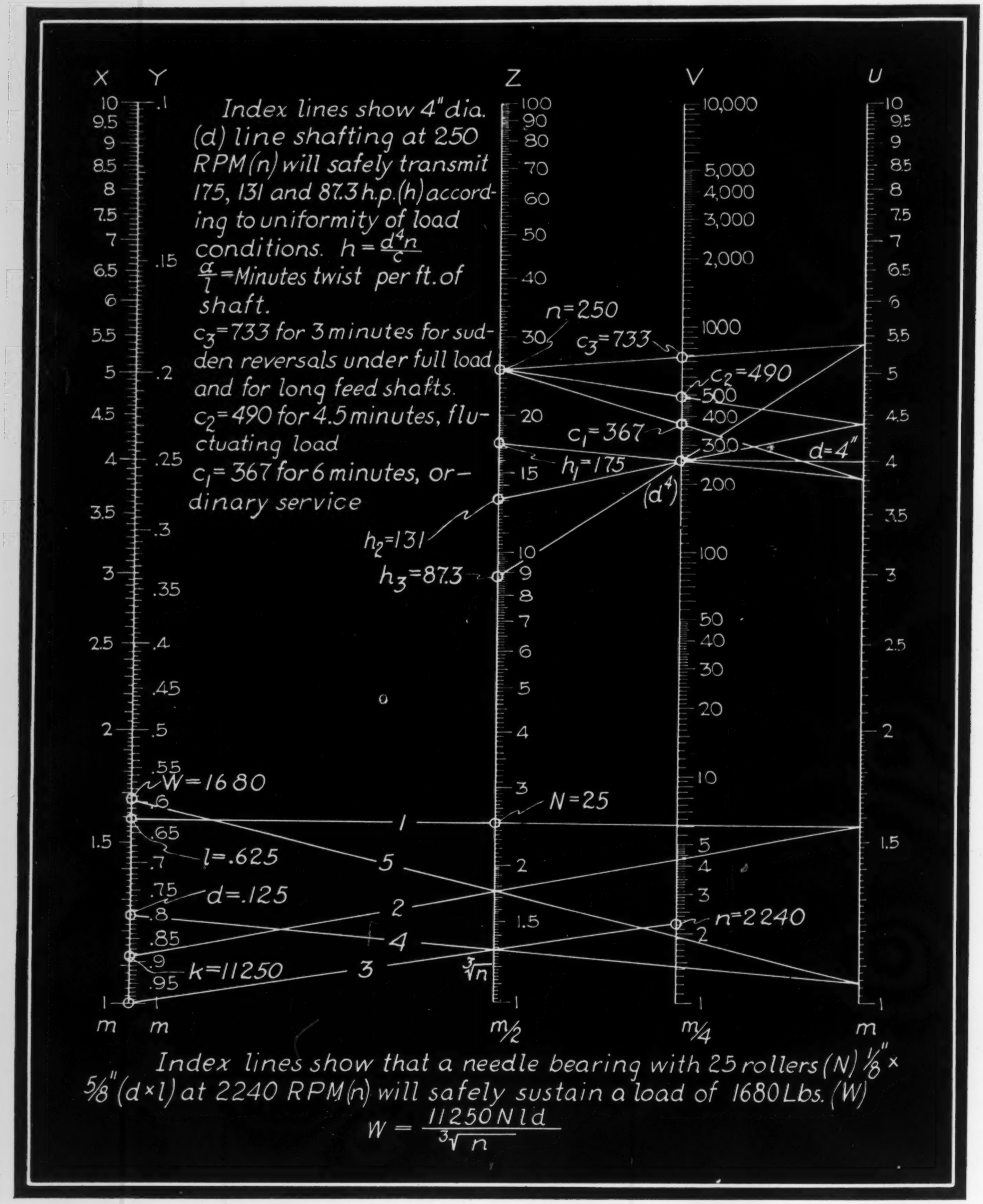
To the Editor:

IT HAS occurred to me after reading the excellent articles on "Designing for Appearance," by Harold L. Van Doren, that industrial styling has arrived at the point where giving an article sales appeal is not sufficient. A few years ago the procedure meant merely cleaning the superfluous detail and ornament from an article and in this way achieving an object that embodied quality, utility, function, sales appeal, and low cost of production—in fact, everything that the manufacturer and consumer desired.

Today—how different! The next time you have occasion to walk through the appliance department of the average department store, try to distinguish one make of refrigerator or stove from the other. We've made them all so simple that in order to find out who manufactures the product it is almost essential to go up closely and read the nameplate. We've streamlined our products into "commonness."

One of these days someone will design a refrigerator or stove that will actually shock the public as did Hood's American Radiator Building. Whoever heard of an all-black building? Ridiculous! Yet it now incites wide acclaim.

—WILBUR HENRY ADAMS
Wilbur Adams & Assoc.



Index lines show 4" dia. (d) line shafting at 250 RPM (n) will safely transmit 175, 131 and 87.3 h.p. (h) according to uniformity of load conditions. $h = \frac{d^4 n}{c}$

$\frac{a}{l}$ = Minutes twist per ft. of shaft.

c_3=733 for 3 minutes for sudden reversals under full load and for long feed shafts.

c_2=490 for 4.5 minutes, fluctuating load

c_1=367 for 6 minutes, ordinary service

Index lines show that a needle bearing with 25 rollers (N) 1/8" × 5/8" (d × l) at 2240 RPM (n) will safely sustain a load of 1680 Lbs. (W)

$$W = \frac{11250 N l d}{\sqrt[3]{n}}$$

How the uniformity of load on long shafting effects the permissible horsepower to be transmitted can be determined from this nomograph as can also data for the design of needle bearings. An explanation of the nomograph appears on page 41

MEN OF MACHINES

RETIREMENT of Dr. Arthur D. Little as president of his organization, Arthur D. Little Inc., brings to attention the achievements of this noted engineer. Educated at M.I.T., he has been actively connected with many important developments, among which are new process equipment for paper making, artificial silk, chrome tanning, cellulose acetate, and others for the production of a long line of alcohols and special products from petroleum.

One of his earliest ventures identified him with the sulphite process for the manufacture of wood pulp. After operating several of the first mills under this process he opened a laboratory in Boston in 1886. Gradually he built up his company which now has research and engineering laboratories at Cambridge, Mass.

ARTHUR D. LITTLE

• • •

S. A. JEFFRIES

CHIEF engineer in charge of all engineering and experimental activities of Stutz Motor Car Co., is the new office being filled by S. A. Jeffries. Since his graduation from Michigan State university in 1913 he has devoted his entire career to automotive engineering.

For nine years Mr. Jeffries was in charge of commercial car design and test work with Reo. Some of the practices now in common usage he helped to pioneer were the dry disk clutch, center control, dual foot control, aluminum alloy pistons, spiral bevel gear axles and rubber engine mounting.

Many patents on transmissions have been obtained by Mr. Jeffries, who also developed one of the earliest transmission locks used in automobiles.

• • •

AWARD of the John Price Wetherell medal by Franklin Institute to Dr. Francis F. Lucas is significant. His development of a technique of microscopy and photomicrography, for which he was honored, has been of distinct value to engineers.

At the present time Dr. Lucas is in charge of the microscopical laboratory at Bell Telephone Laboratories Inc. At the outset of his work he found the limit of magnification generally accepted at 1500 diameters. He has successively increased it, first to 3500, then to 5000 and most recently to 6900 in co-operation with the scientific staff of the Zeiss Works at Jena, Germany.

One of his outstanding achievements has been the evolution of techniques which make practical the use of ultra-violet light in high-power photomicroscopy. In addition to his connection with

FRANCIS F. LUCAS

Bell Laboratories, Dr. Lucas is a consulting engineer on microscopy and metallography. In 1924 the American Society for Steel Treating, now the American Society for Metals, awarded him the Henry Marion Howe medal and in 1926 he received the medal of the Royal Photographic society for his photomicrographs of metals.

* * *

A. A. Ross was elected president of the American Gear Manufacturers association at recent annual meeting. He is in charge of the centralized engineering and manufacturing gear departments at the West Lynn, Mass., plant of the General Electric Co.

* * *

Prof. Thomas H. Harrington, assistant to the deans of Columbia college and the School of Engineering at Columbia university, is retiring at the close of the school year. He has been a member of the faculty for forty years.

* * *

Knutt Nordensen, for many years chief designer of McIntosh & Seymour Corp., recently was appointed chief engineer, a position made vacant by the resignation of Paul A. Ritter Sr., who has been chief engineer for ten years. Carl Volmar Anderson succeeds Mr. Nordensen as chief designer.

* * *

William Frederick Durand, recently was awarded the Daniel Guggenheim medal for 1935 for notable achievement as a pioneer in laboratory research and theory of aeronautics as well as distinguished contributions to the theory and development of aircraft propellers.

* * *

Kenneth G. Castleman has succeeded to the position of secretary of the Association of Manufacturers in the Aluminum Industry to fill the vacancy created by the resignation of Donald McDonald. Mr. Castleman will be located at 1747 Graybar building, New York.

* * *

Dr. Frank B. Jewett, president of Bell Telephone Laboratories Inc., has become national chairman of the campaign to raise the working capital fund of $161,000 for Engineering Index Inc.

* * *

F. M. Farmer, vice president of the Electrical Testing Laboratories recently was re-appointed chairman for the year 1934-35 of the American Institute of Electrical Engineers' technical committee on research.

* * *

Lawrence W. Wallace, vice president of W. S. Lee Engineering Corp., Washington, has been made director of equipment research by the research advisory board of the Association of American Railroads.

* * *

Sydney G. McAllister, recently was elected president of International Harvester Co. He has been affiliated with the organization for 38 years. In 1931 Mr. McAllister was elected vice president in charge of engineering, traffic, fiber and patent departments, in 1932 he took charge of manufacturing and engineering, and since May 4, 1934, has been first vice president.

* * *

Dr. John Chipman has been appointed associate director of the research laboratories of American Rolling Mill Co.

* * *

Andrew M. Ondreyco, until recently operating metallurgist for Westinghouse Air Brake Co., has joined the Meehanite Corp. in the capacity of chief metallurgist.

* * *

Alfred Moorehouse has been appointed chief engineer of the automotive division of Morse Chain Co. He will have his headquarters in Detroit.

* * *

Dr. Dugald C. Jackson, since 1907 head of the electrical engineering department of Massachusetts Institute of Technology, will retire at the close of the current academic year.

* * *

T. M. Girdler, chairman and president of Republic Steel Corp., has been named one of twenty-nine leaders of mining and allied industries to serve as an advisory board to the United States bureau of mines.

* * *

Edward R. Weidlein, director of the Mellon Institute of Industrial Research, Pittsburgh, will be awarded the Chemical Industry medal for 1935 by the American section of the Society of Chemical Industry. Presentation will be made this fall.

* * *

Prof. Harold L. Hazen, exchange professor from Ohio State university in the electrical engineering department of Massachusetts Institute of Technology, has been awarded the Levy gold medal of the Franklin Institute for his outstanding paper on the theory and design of servo-mechanisms.

* * *

Ralph A. Terrell recently joined the Ingersoll Steel & Disc Co., division of Borg-Warner Corp., at its West Pullman (Chicago) plant, as chief engineer. He succeeds S. S. Battles who resigned to become president of Midwest Stamping & Enameling Co.

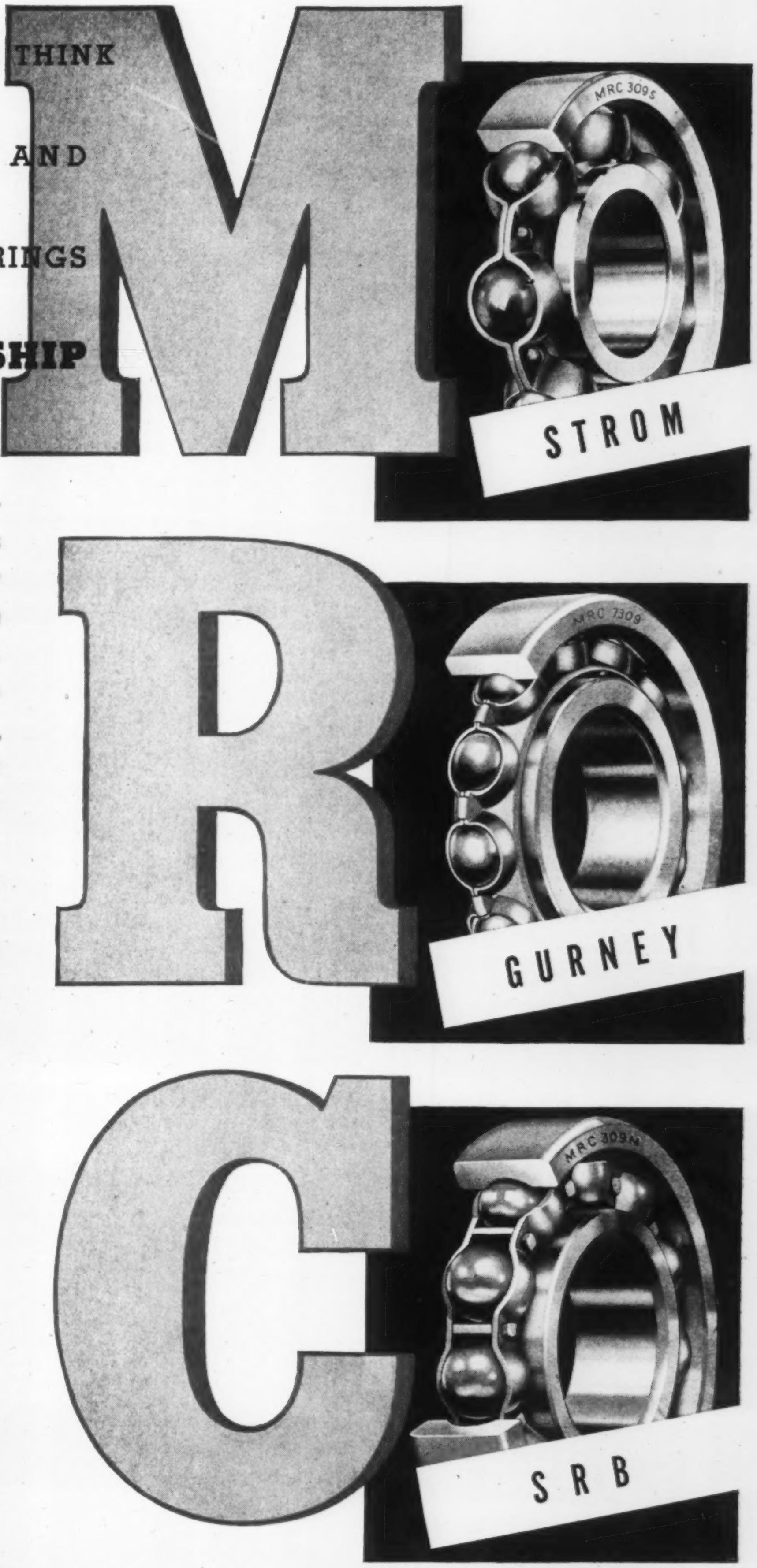
Obituaries

Charles A. Paeschke, seventy-seven year old president of Geuder, Paeschke & Frey Co., Milwaukee, died recently. With William Geuder, he founded the company in 1880 and was active head of it at the time of his death.

* * *

Stewart A. Jellett, charter member, presidential member and honorary member of the American Society of Heating and Ventilating Engineers, died recently in Philadelphia at the age of 73. From 1912 until the time of his death he was president of the company which bears his name, and was responsible for the design of many noteworthy heating, ventilation and electric generating projects.

A CONVENIENT WAY TO THINK OF 3 FAMOUS MAKES AND 23 TYPES OF BALL BEARINGS UNDER **ONE LEADERSHIP**



Throughout the machinery industry hundreds of manufacturers have relied on the dependability of Gurney — SRB and Strom Ball Bearings year after year. Through habit many still refer to them by their original names. These three famous makes have long been combined into a single organization—M-R-C—a combination that represents definite advantages to the ball bearing user. 23 highly developed bearing types . . . most extensive range of sizes in the industry . . . 37 years of manufacturing and engineering experience are the foundation upon which M-R-C Leadership is based.

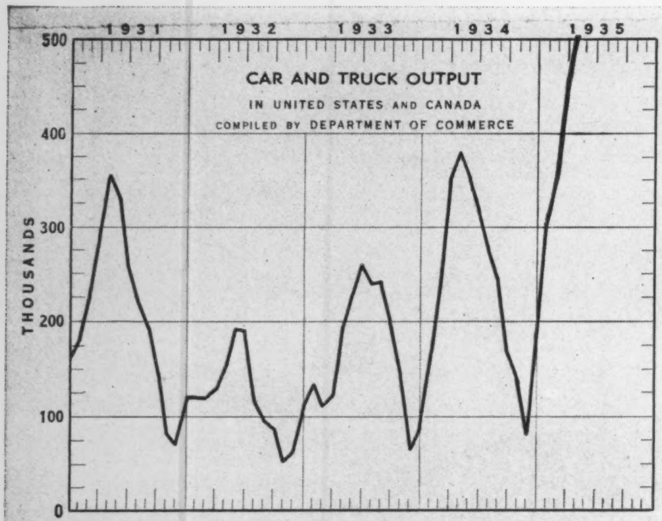
Leadership

M-R-C
Strom
SRB
GURNEY
BALL BEARINGS

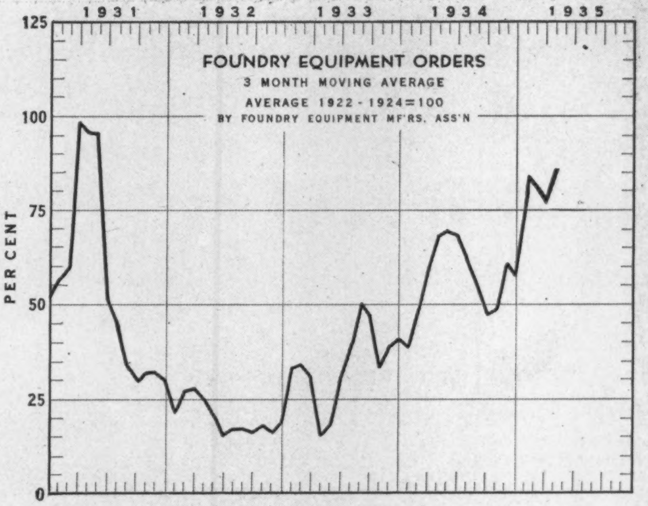
MARLIN-ROCKWELL CORPORATION

EXECUTIVE OFFICES—JAMESTOWN, N. Y.
FACTORIES: JAMESTOWN PLAINVILLE, CONN. CHICAGO

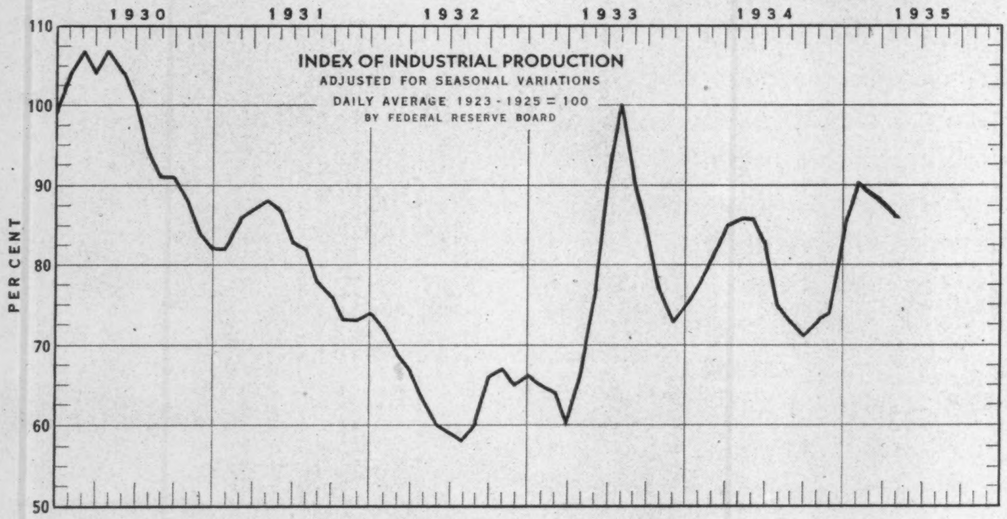
How Is Business?



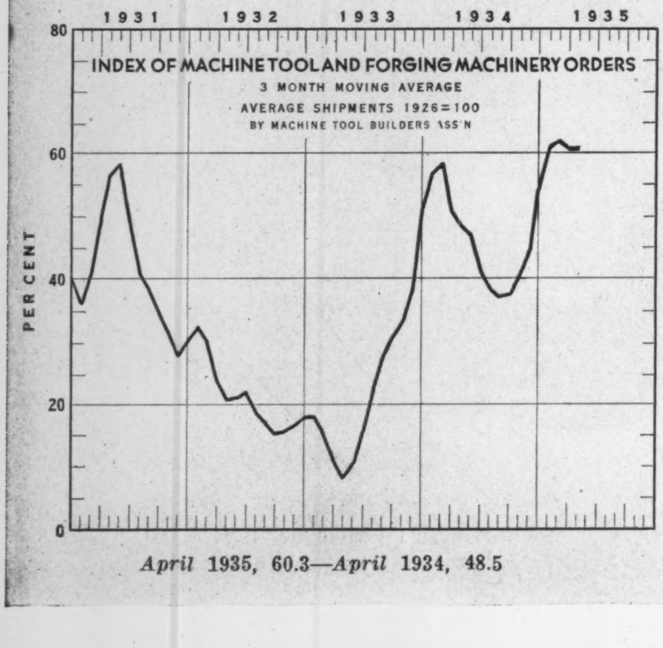
April 1935, 501,837—*April* 1934, 371,338



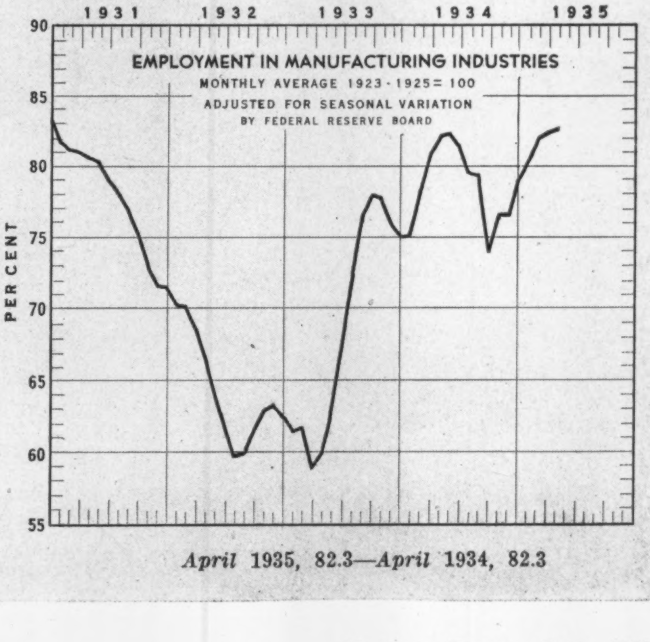
April 1935, 86.0—*April* 1934, 69.7



April 1935, 86—*April* 1934, 85



April 1935, 60.3—*April* 1934, 48.5



April 1935, 82.3—*April* 1934, 82.3

*New

Century

SQUIRREL CAGE POLYPHASE MOTORS

AIR CONDITIONING

and General Purpose Applications

**New!* Century Squirrel Cage Polyphase Motors!

**New* overall ability that meets all demands of all types of Air Conditioning Installations—more exacting than any other.

**New* design and performance, as only a test under your own operating conditions will demonstrate.

Rigidity that withstands shocks, strains, and stresses of heavy drive conditions.

**New* Eye Value that adds **New* Sales Value to any motor-driven product you make.

1/6 to 600 Horse Power . . . Consult Century Engineers.

CENTURY ELECTRIC COMPANY
1806 Pine Street , , , St. Louis, Mo.
Offices and Stock Points in Principal Cities

**New* BULLETIN

No. 6-1-1 . . . Illustrates and describes construction and design features of these **New* Century Squirrel Cage Induction Polyphase Motors.

Century
POLYPHASE MOTORS
1/6 TO 600 HORSE POWER
CENTURY ELECTRIC CO.

Century

MOTORS

TOPICS

OF SIGNAL interest to engineers is the publication of a "Manual of Gear Design," in two parts, bearing the A.G.M.A monogram. Announcement of this contribution to technical literature was made at the recent meeting of the American Gear Manufacturers association at Wilkinsburg, Pa. The volumes were edited by Prof. Earle Buckingham and will be reviewed in the July issue of MACHINE DESIGN.

Among major subjects discussed at the technical sessions of the gear meeting was the production of gears for noiseless operation. "Trick" tooth shapes are of no value in taking noise out of gears, S. O. Bjornberg, Illinois Tool Works, declared. R. S. Drummond, National Broach & Machine Co., described a method of finishing gears, after they had been cut to within 0.004-inch of true dimensions, by shaving. Slight errors in gears following heat treatment may be eliminated economically on a production basis by lapping, it was shown in a paper read by D. T. Hamilton, Fellows Gear Shaper Co.

By unanimous vote, members of the association placed that body in opposition to continuation of existing NRA codes (since declared unconstitutional) following June 16. H. H. Kerr President, Boston Gear Works Inc., presiding over the meeting, declared that industry was given a fine chance at self-government under NRA but did not take advantage of it and failed to demand its rights.

* * *

Patent Commissioner Gives Statistics

Statistics released recently by Conway P. Coe, commissioner of patents, disclose that all except three of the principal divisions of the patent office have shown gains in activities during the first eight months of the current fiscal year, as compared with the same period in 1934. Because a large number of applicants failed to pay the final fee on applications allowed by the commissioner and ready to go to patent, the total income of the office for the first two-thirds of the present fiscal year was $79,205.22 below that for the same months in 1934.

In the first eight months of 1934 the gross receipts of the office were $2,726,498 as against $2,647,292 in the corresponding period of this year. Returns from the sale of copies of patents, trademark certificates, etc., thus far in 1935 have exceeded by $12,445 those for the same period of last year.

* * *

The composite senior in this year's graduating class at Columbia school of engineering is a man 24 years old, growing bald, "one-twelfth married" and expects to have an annual income of $3330 by 1940.

* * *

Shorts on This and That

Most of us can recall the days when mere mention of aluminum suggested kitchen utensils, but look what engineers are doing with it now in connection with streamlined trains (page 23).

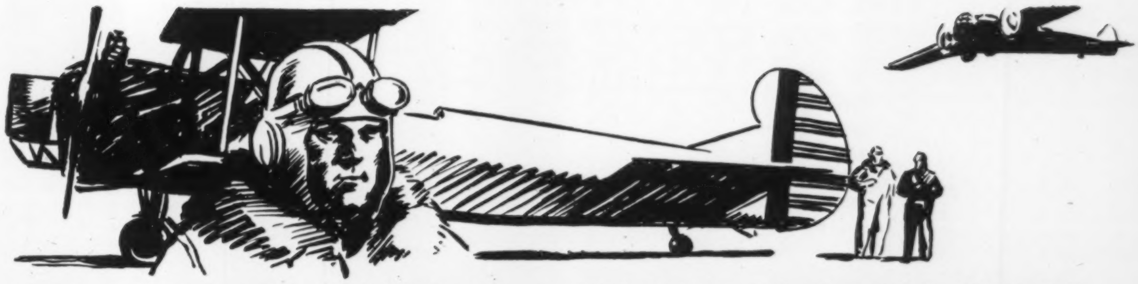
And speaking of engineering materials notice the article on ferrous castings (p. 24)—it may tell you something about them you didn't know.

Or if at the moment you are more concerned with drives than materials it will interest you to see what DeVry has accomplished with a silent chain (p. 29).

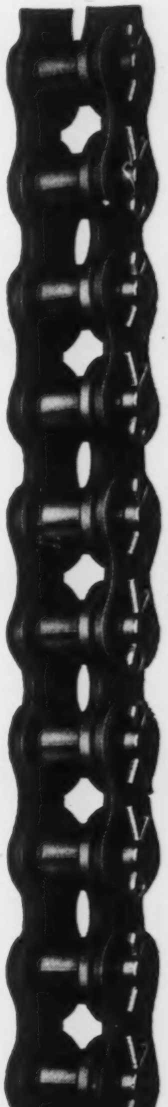
Bearing information never comes amiss, especially if it treats practical aspects connected with the use of antifriction types (p. 33).

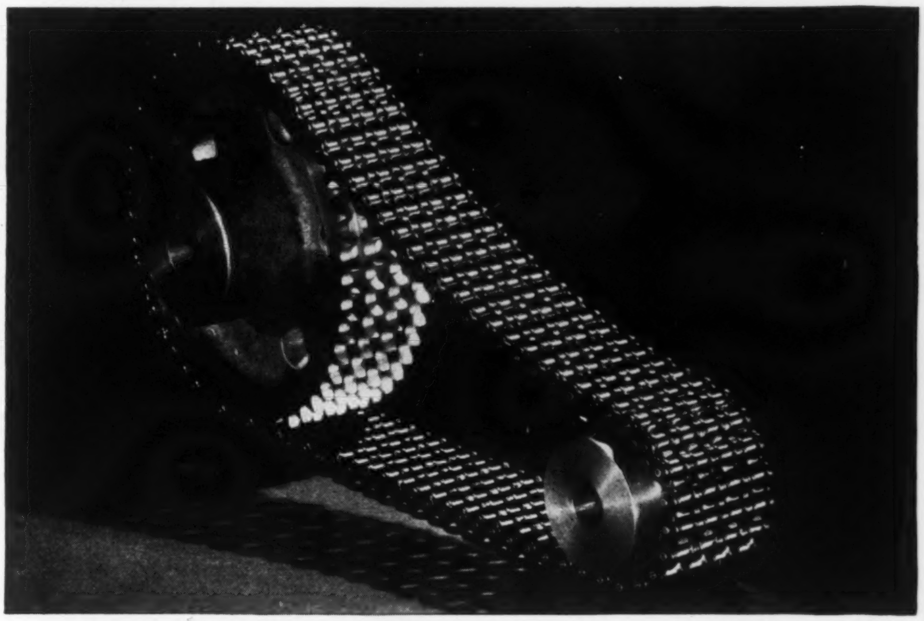
Modeling is as old as the hills but even so you might have overlooked its current possibilities (p. 27).

And last but not least, there's much in the proposed code for fusion welding and flame cutting in machinery construction that deserves your profound attention (p. 32), to say nothing of the radical new speed changer (p. 21) and the new approach to design (p. 15).



IF CHAIN WERE A NEW INVENTION . .





MANY NEW WAYS OF APPLYING IT WOULD BE FOUND

Rex Roller Chain Drive *is positive*—and 98% efficient—which makes it the most efficient means known of transmitting power.

It is long-lived—wear is very slow, as the smooth, exact surfaces of its rollers roll smoothly in and smoothly out of the accurately cut sprocket teeth.

It can be fully enclosed, completely lubricated in oil-tight housings where difficult operating conditions prevail.

It can be applied on extremely short centers—and maintains its absolute ratio between speed of drive and driven shafts.

There are new ways of applying Power

Rex Chain Drives today offer many new opportunities for economies and improvements in many types of drives today.

Application Engineers of the Chain Belt Company are always available to help work out your drive problems, with a complete line of standard and special Rex Roller Chains, 3/8 to 2½-inch pitch and 270 standard Rex Chabelco Steel Chains or any Special Chain your service may require.

CHAIN BELT COMPANY
1643 W. Bruce St., Milwaukee, Wis.

CHAIN BELT COMPANY

REX CHAIN AND BELT CONVEYING

NOTEWORTHY PATENTS

TO ARREST the lateral movement of a typewriter carriage after it has been retracted to a position beyond the marginal position and to utilize the energy stored in a shock absorbing mechanism to advance the carriage subsequently to marginal position are objects of a newly patented invention. The conventional spring motor 7, *Fig.* 1, *C,* exercises a continuous effort to move the carriage 1 to the right. This movement, however, is restrained by an escapement mechanism, except when a key of the typewriter is depressed.

As the carriage, when moved in a retracting direction in preparation for the beginning of a new line of writing, approaches the left-hand margin its abutment 6, *Fig.* 1, *B,* contacts the margin stop 4, whereupon continued travel of the carriage draws feed rack 5 along so that the carriage and rack move as a unit beyond the marginal position against the combined efforts of the spring motor 7 and the resistance set up in the shock absorbing device 23.

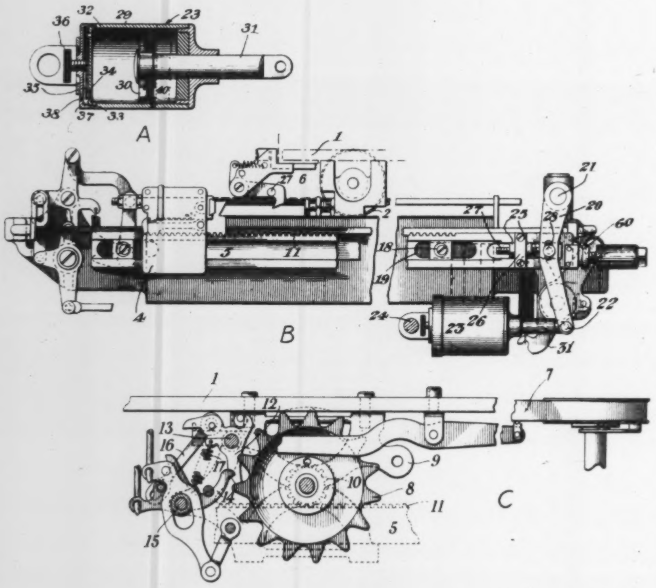


Fig. 1—*Shock-absorbing mechanism utilizes compressed air to control movement of typewriter carriage*

When the rack 5 is in normal position piston 30, drawing *A,* lies in the dotted line position shown, the piston having been so placed by its connection with the rack. In such position there is a compression of fluid between the piston and the adjacent cylinder head, sufficient to form a cushion. The piston in its normal position uncovers port 40 for communication with the chamber formed between the piston and cylinder head 32.

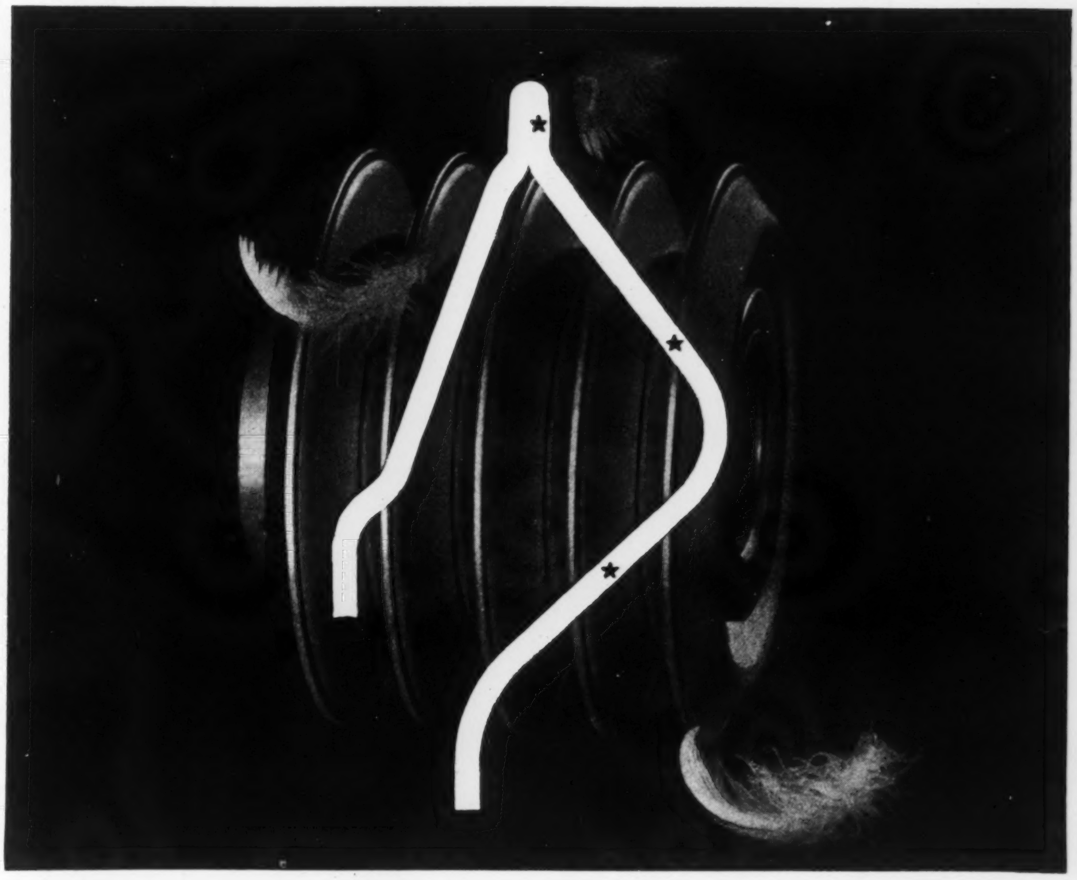
Resistance to movement of the shock absorbing mechanism from its normal position is occasioned by the compression of the air in the head or left end of cylinder 29. It will be noted in this connection that the extent of such resistance may be controlled by regulating the position of valve 32 with respect to port 33 through screw 36. Thus the device is adaptable for use on carriages of varying weight and speed.

Momentum of the carriage having been overcome, and both the carriage and feed rack arrested at a point to the left of the normal left-hand marginal position, it now is desirable to advance the carriage quickly in a reverse direction to the predetermined marginal position and restore rack 5 to its normal position. Energy stored in the compressed air to the left of piston 49 in the shock absorbing device 23 is effective in advancing the carriage and rack, this by reason of the fact that the opposite end of the cylinder is vented to the atmosphere through port 40 and such compression supplements the action of spring 7 in accomplishing this purpose.

The patent is designated No. 1,992,940 and is assigned to Underwood Elliott Fisher Co., New York. Harry A. Foothorap, Harrisburg, Pa., is inventor of the device.

BY MOUNTING an oil reservoir on a rotating shaft, centrifugal force has been employed advantageously in a new lubricating system for sewing machines. As shown in *A, Fig.* 2, this reservoir 36, rotating with main shaft 7 within gooseneck 2, 3, is comprised of a cylindrical casing through which shaft 7 passes. Drawing *B* is a section on line 2-2 of *A.*

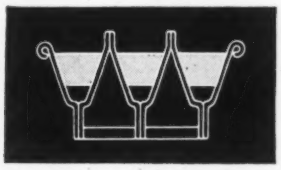
Packing glands 35 at the opposite end of casing 34 constitute oiltight seals and hold the casing against slippage on the main shaft. Oil cavity 36 may be supplied with lubricant through an opening normally closed by removable filler screw plug 37. Mainshaft 7 has a longitudinal



LIGHTNESS

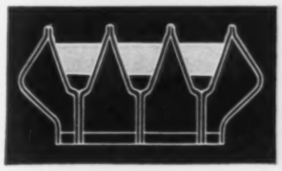
Engineering science advances... old beliefs crumble... weight gives way to lightness—lightness that makes no concession to strength. • The new Duro-Brace sheave, for Texrope V-Belt drives, is the lightest sheave on the market, in relation to its great strength. Thus it reduces bearing pressures to a minimum. • In the newly designed Duro-Brace Texsteel sheave the outside walls are reinforced by convex steel plates which so greatly increase their strength as to eliminate distortion, even under the severest duty. The result is a light, true-running, vibrationless drive always. • Texrope drives are 98.9% efficient, silent, slipless, shock-absorbing, require no belt dressing or lubrication, and are not affected by dirt or moisture. • Mail us a card asking for Bulletin No. 2188 which sets forth the advantages which Duro-Brace Texsteel Drives offer you in all matters of power transmission, whether they be simple or complex.

Former Design: cross-section showing unsupported outside plate.

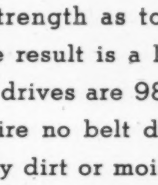


★ ★ ★

New Duro-Brace Design: cross-section showing outside plate braced by a convex reinforcing steel plate.



TEXROPE DRIVES



ORIGINATED BY ALLIS-CHALMERS

ALLIS-CHALMERS MANUFACTURING COMPANY • MILWAUKEE, WISCONSIN

oil-duct 38 leading to the needle-bar actuating crank 18.

When the machine is running the oil in the reservoir is swirled around the axis of the shaft by centrifugal action and none enters the axial duct 38. As the machine stops, however, a small quantity of oil enters duct 38 through lateral duct 39 and works its way along duct 38 from which it passes through duct 40 in rotating crank 17 to hollow crankpin 18. From this point the upper end-bearing of link 19 and the take-up actuating crankpin 28 are lubricated through suitable oil-distributing ducts. These parts previously were lubricated from the main-shaft sleeve bearing adjacent the needle-bar actuating crank.

Excess oil from the crankpins 18 and 28 collects in oilwell 41 in head 4 from which it is carried by wick 42 to the felt pad 43 engaged by arm 27 of the vibratory take-up lever 25, 27, thereby lubricating it.

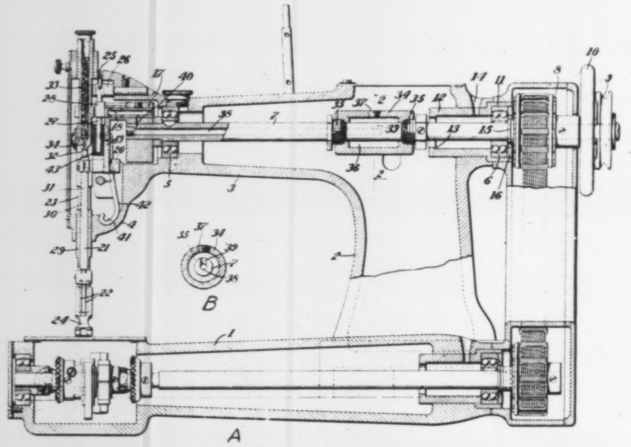


Fig. 2—Centrifugal force controls oil flow from revolving reservoir in sewing machine lubricating system

Walter Myers is the inventor of the system which recently was granted patent No. 1,998,588, assigned to Singer Mfg. Co.

AUTOMATIC control of a washing machine is effected through the use of a timing device recently granted a patent which has been assigned to Nineteen Hundred Corp. The idea is worked out so that relation between worm 28, *Fig. 3*, worm wheel 29, toothed wheel 19 and operating finger 20 is such as to permit calibration of dial 33 to indicate definite time intervals, for example, minutes. Knob 32, pulled out in operation to disengage the worm and wormwheel, then is rotated until any desired graduation on the dial 33 is brought into line with the index mark on member 34.

If the operator wants the machine to wash for a period of say fifteen minutes the graduation 15 will be brought into line with the index. This serves to carry pin 35 a corresponding distance in clockwise direction, away from the lever arm 36 of the switch which is positioned in the electric circuit to the motor that drives the washing machine.

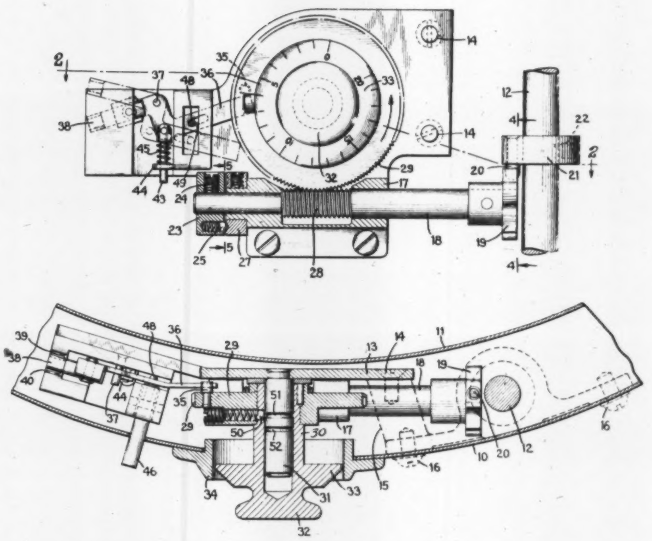


Fig. 3—Gears and a toothed wheel are employed in an ingenious timing device for washing machines

Knob 32 now may be depressed inwardly to connect the worm and wormwheel, after which the machine is set into operation by depressing finger piece 46 that serves to close the switch formed by elements 38, 39 and 40. The motor then will drive the washer and wringer shaft 12, the latter upon each rotation turning wheel 19 through one tooth space by means of projection 20. Worm 28 drives wormwheel 29 in a counter-clockwise direction until pin 35 engages and depresses switch arm 36. When this occurs the circuit to the driving motor is broken and the machine stops.

The inventor of the device is Gustav B. Keil to whom patent No. 2,000,448 has been granted.

Review of Noteworthy Patents

Other patents pertaining to design are described briefly as follows:

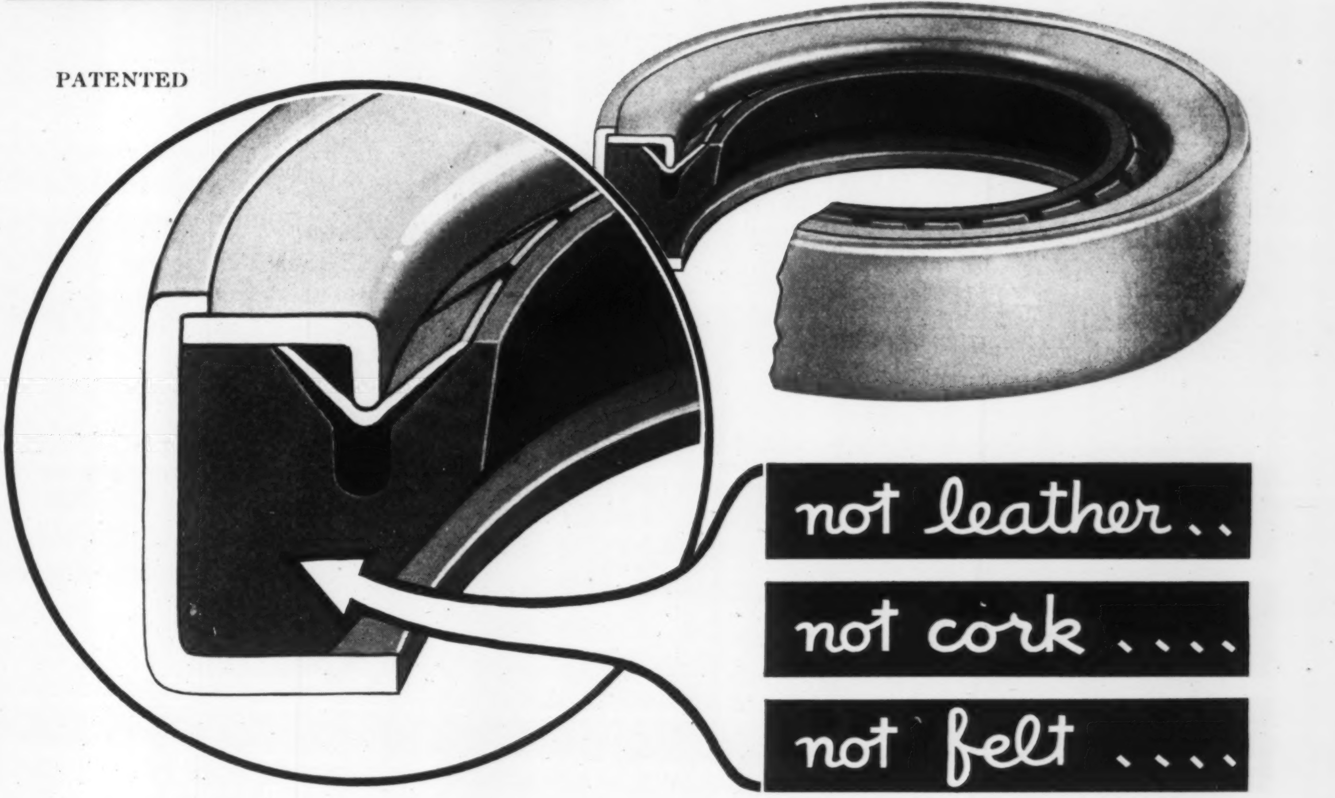
FABRIC TAKE-UP MECHANISM—1,991,563—The device covered by this patent is designed for use on knitting machines and serves to maintain the knitted fabric under uniform tension at all times. Assigned to Nolde & Horst Co., Reading, Pa.

VIBRATION DAMPENER — 1,993,126—The general purpose of this mechanism is to permit the driving of one element by the other, but at the same time to absorb or diminish the torsional vibration. Assigned to Russell Mfg. Co., Middletown, Conn.

MANICURING APPARATUS—1,988,581—Features of this newly patented machine include interchangeability of instruments and the use of a reciprocating movement. Assigned to Vivian Beauty Shoppe Inc., Cleveland.

KLOZURE THE NEW GARLOCK OIL SEAL

PATENTED



This Sealing Ring is a Special Garlock Compound—Dense, Grainless and Tough!

THE most vital part of an Oil Seal is the sealing ring. To seal a bearing effectively, the ring must *resist oil and heat*. It must be *tough* and *durable*. For long, efficient service, the ring should also be *non-porous, non-abrasive* and *resilient;* finally it should not produce excess friction.

The sealing ring in the GARLOCK KLOZURE has *every one* of these characteristics. It consists of a *dense, grainless* compound specially developed in the Garlock laboratories for this specific purpose. It is molded to exact size; performance is uniform and efficient. Complete range of sizes. Write for descriptive booklet !

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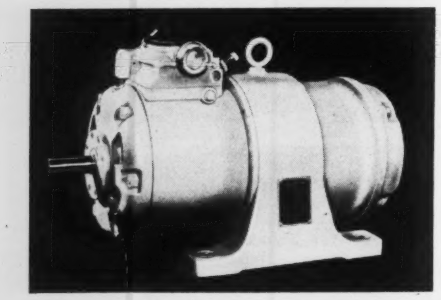
GARLOCK

NEW MATERIALS AND PARTS

Rollers Transmit Torque

HARDENED steel rollers in pressure contact with equally hard steel races are utilized to transmit power in the Transitorq unit perfected by New Departure Mfg. Co., Bristol, Conn. The rollers which transmit the drive from the constant speed input race to the variable speed output race are mounted in a nonrotatable spider. Each roller, being carried upon a ball bearing, is free to revolve about its own axis and in addition to this may be rocked a limited distance about an axis at right angles to it. As a result, the rollers may be adjusted to any position relative to the races from the lowest to the highest speed ratio positions, providing infinitely variable speed. A further discussion of the working principle and a cross section of the device is given on pages 21 and 22.


A variety of mounting conditions may be accommodated in the construction of unique power unit

The construction of the power unit, shown herewith, is such as to accommodate a wide variety of mounting positions. Automatic or remote controls are easily engineered into any type of driven machine to suit installation. Motor shaft and output shaft are in line. As the drive unit may be built into the machine, it is adaptable to any drive problem requiring an infinitely variable speed. Either manual operation through a handwheel located on top of the unit, or remote control can be used to regulate the drive.

Alloy Resists Corrosion

EXCEPTIONAL resistance to corrosion and high tensile strength combined with high ductility, workability and weldability is afforded by a new alloy steel just announced by Youngstown Sheet & Tube Co., Youngstown, O. This new product, known as Yoloy, is a nickel-copper alloy steel and is produced in sheets, strips, plates, bars, shapes, wire and seamless pipe.

Magnetic Brake Has Few Parts

SIMPLE in design and construction, with a minimum number of moving and wearing parts, a new magnetic disk brake, known as style "DS", has been brought out by Magnetic Mfg. Co., Milwaukee. The new high duty brake, shown herewith, can be supplied for either alternating or direct current operation; five sizes ranging from 10 to 90 foot pounds torque for continuous duty operation being available. Design of the brake includes manual release; lining wear indicator; constant torque provided at all times and not subject to variation from lining wear; simple and practical adjustment for torque and lining wear; and easy replacement of linings when necessary. The symmetrical outline of the unit enhances its appearance.

A minimum number of parts is employed in design of magnetic disk brake

New Plastic Can Be Sand Buffed

DEVELOPED especially for machine parts and other plastic parts requiring sanding or machine operations and subsequent repolishing, the new Durez material introduced by General Plastics Inc., North Tonawanda, N. Y., has a flexural strength of 10,000 pounds per square inch and a compressive strength of 28,000 pounds per square inch, and molds on regular

Tubing
BY
SUMMERILL

A RECORD *of* PROGRESS

Progress in the manufacture of seamless steel tubing—progress in the adaptation of this versatile product to the needs of industry—are both recorded in this new book "Tubing by Summerill."

Primarily a catalog, it is also a data book on seamless tubing specialties and their uses throughout industry—illustrated, carefully compiled, well printed—containing much original information never before available in printed form.

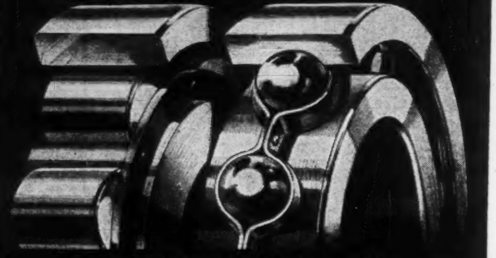
Business executives, engineers, designers, production and operating executives in the metal working industries are invited to write for copies of this book. It will be appreciated if requests are written on your business letterhead.

SUMMERILL TUBING COMPANY

SPECIALISTS IN TUBING SPECIALTIES

BRIDGEPORT, MONTG. CO., PENNSYLVANIA

TWIN



PRECISION

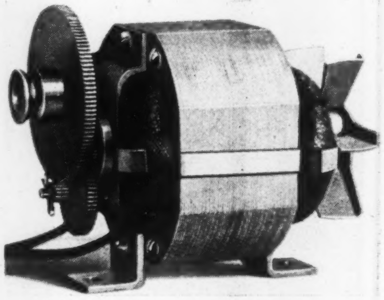
IN the past 20-odd years many standards have become flexible, and quality has—in many cases—become a variable thing . . . But throughout this period NORMA-HOFFMANN Precision Bearings have been consistently made to the highest standard of excellence . . . They continue to be the choice of those who measure value by service rendered, and who seek the lowest cost per bearing per year of useful life . . . *Write for the Catalog. Let our engineers work with you. . . . .*

"NORMA-HOFFMANN"
PRECISION BEARINGS
BALL, ROLLER AND THRUST
NORMA-HOFFMANN BEARINGS CORPORATION,
STAMFORD, CONN., U. S. A.

cycles. Many decorative objects are sometimes partially machined or sand-buffed for certain reasons. On ordinary molding materials the sanding or buffing will uncover flecks of the fibrous filler and in general spoil the color. This new material, called 114 SB black, has a greater depth of color, and a peculiar make-up which permits subsequent polishing to a soft, satiny luster even after complete grinding away of the natural surface.

Small Motor Has Center Drive

A NEW two-pole, single-phase induction shaded pole type motor with center drive is a recent development of Signal Electric Mfg. Co., Menominee, Mich. The motor, shown herewith, is rated at 1/110 horsepower and is furnished for operation on 60 cycles only, 110 and 220 volts. It is claimed that this motor has an unusually low temperature rise for motors of this type. Bearings are oilless—bronze impregnated with graphite—and wool packed oil reservoirs assure proper lubrication.

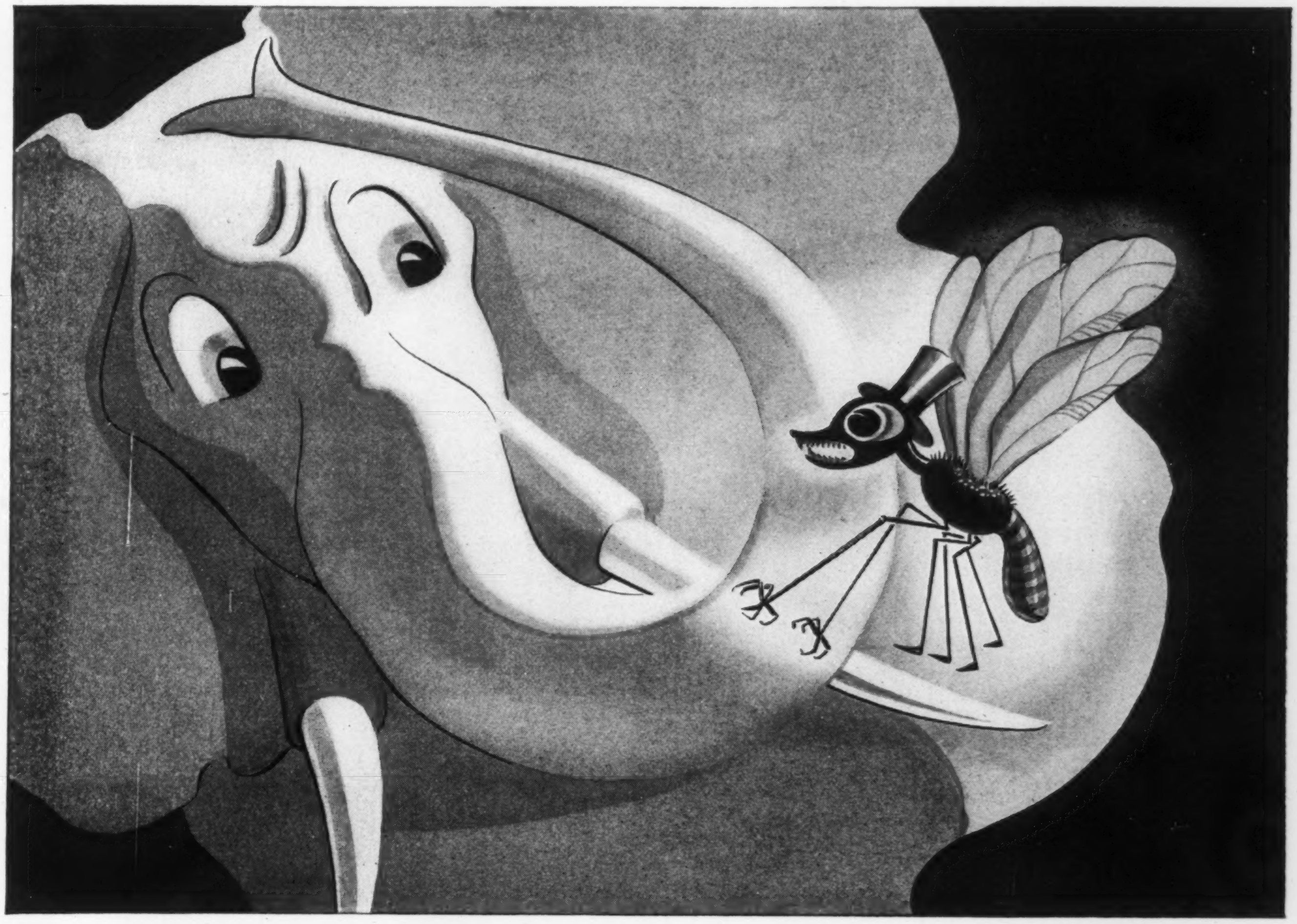


Two-pole motors of shaded pole type have an unusually low temperature rise

This motor was designed to operate a 10-inch diameter flat blade fan and for sign display mechanisms, but it lends itself to a number of other applications. It is furnished in three different forms for intermittent and continuous service: Skeleton less gear reduction, skeleton with gear reduction—24:1 or 48:1 ratios, or in a frameless gear reduction.

Introduces Improved Nickel Alloy

DEVELOPED to meet special casting applications, the new S Monel of International Nickel Co., New York, is somewhat similar in analysis to regular Monel metal, the essential difference being in silicon content which has been raised to a maximum of 3.75 per cent. In properties, the new material has a higher hardness than the regular grade of Monel metal and greater resistance to wear and erosion, particularly steam erosion. It is nongalling, especial-



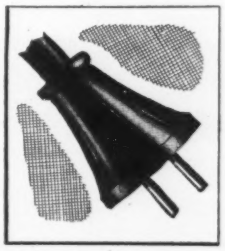
A tiny TSETSE FLY can kill an elephant!

A Poor Accessory Can Kill The Acceptance of Your Appliance

A tiny insect — but the elephant's worst enemy. The Tsetse Fly burrows into the elephant's ears and other vulnerable places and deposits a parasite which breeds the terrible disease of *nagana*. Whole herds of elephants may be wiped out!

Similarly, the small cord set may wreck the performance of an otherwise perfect appliance. Customers will condemn the appliance when the accessory is to blame!

Take no chances. Use General Electric Accessory Equipment, of established strength, dependability and permanence. The G-E All-rubber Plug is moulded directly on the cord in one piece — *the "Unicord" cannot come apart*. Prevents breakage — loose connections — short circuits. The cord can be silk-, cotton-, or rubber-covered.



Molded on the Cord—
Not Simply Attached.

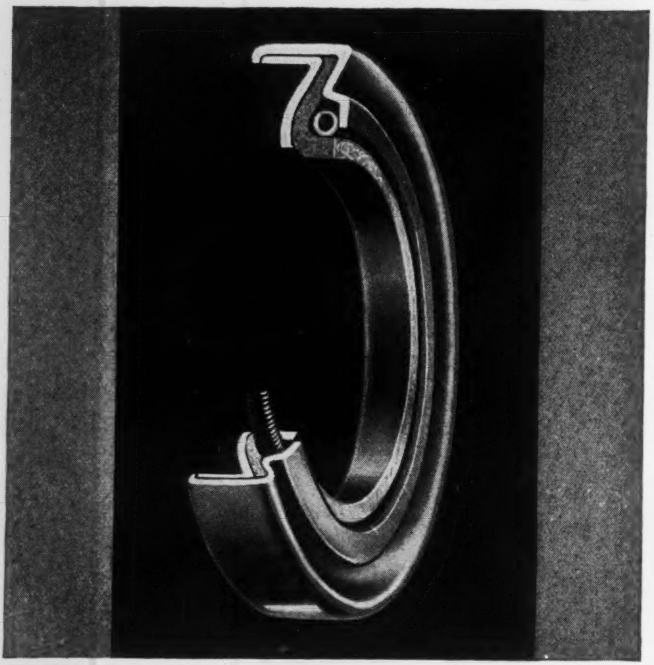
Give your customers the full measure of quality they expect when they buy your appliance. A representative will gladly call and discuss G-E Unicords with you. Write today, Section Q-326, Merchandise Department, General Electric Company, Bridgeport, Connecticut.

GENERAL ELECTRIC

ACCESSORY EQUIPMENT

MERCHANDISE DEPARTMENT, GENERAL ELECTRIC COMPANY, BRIDGEPORT, CONNECTICUT

MILPACO



OIL SEALS

Why You Should Use Them

No part or process is left to guess or chance. Every detail of design and construction is backed by sound engineering principles, and practical application. The material for each part is selected by exact methods—chemical and physical analyses, and engineering tests in the laboratory and in the field as well. They are absolutely uniform in quality and construction. They can't help having more sealing ability, and standing up in service longer—and they do.

Our engineers can and will be pleased to give you more, interesting information on Milpaco Oil Seals, and we believe our oil seal bulletin No. 302 will also interest you.

S102

MICHIGAN LEATHER PACKING CO.
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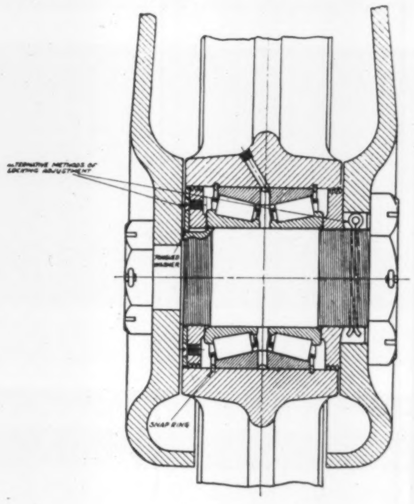
ly at high temperatures.

The as-cast material can be machined without difficulty if the hardness is held to 325 brinell by limiting the silicon to 3 per cent. The harder grades must be softened for machining and later rehardened by heat treatment.

Mounting Accuracy Is Insured

TO SIMPLIFY the machining problems developed by the increasing use of manganese steel in crane and hoist sheaves, and to insure accuracy of mounting, Timken Roller Bearing Co., Canton, O., has developed a new type of bearing mounting using double cup bearings.



New type of bearing mounting simplifies machining problems

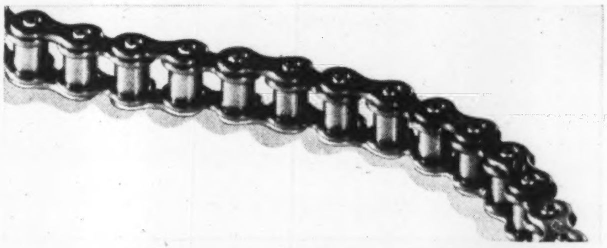
This new type of mounting permits the sheave hub to be bored straight through at a single setting. In the design shown, the cup is located by means of snap rings. In an alternate design the bearing cup is pressed into the hub and located by means of end caps. In another, the location of the cup depends upon its press fit in the hub. These basic designs can, of course, be modified to combine the desired bearing mounting with the type of side frame construction used.

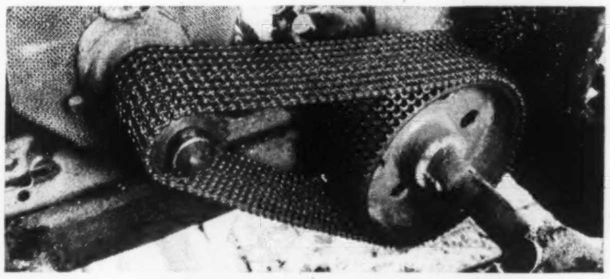
Improves Conduit Products

THREE improvements have been announced in the line of conduit products manufactured by Merchandise Department, General Electric Co., Brideport, Conn. All couplings, including small sizes, now are beveled at both ends. This manufacturing practice, which previously applied only to larger couplings, permits easy starting of the conduit on the coupling and saves time in installations.

Threads on "White" conduit are now hot-dipped, galvanized, and Glyptal-coated. This procedure provides additional protection at the

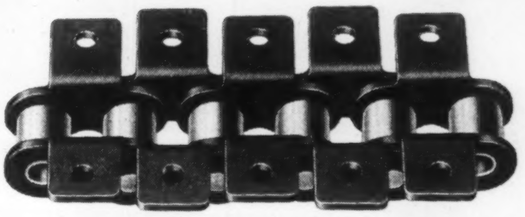
Is it Power Transmission?..or Conveying? . . . or is it a Timing Job?

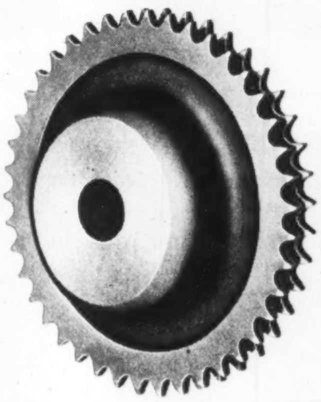


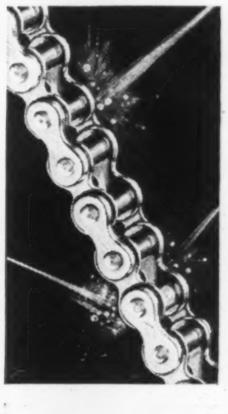


Diamond Roller Chain Will Do All of These—With Never a Slip

- **Single Strand Chain—**
  for the inter-machine, shaft-to-shaft drives or timing operations.
- **Multiple Strand Chain—**
  from 2 to 10 strands for the high speed heavy duty power drives—capacities to 450 h.p., speeds to 4000 r.p.m.
- **Chains with Special Attachments—**
  for conveyors and conveying systems.
- **Stainless Steel Chains—**
  for resistance to extreme heat and corrosion.
- **Sprockets—**
  for all requirements. Accurate to the extremely close tolerances so necessary for high efficiency and long, uniform wear.
- **Flexible Couplings—**
  for simple long-lived direct shaft connections.







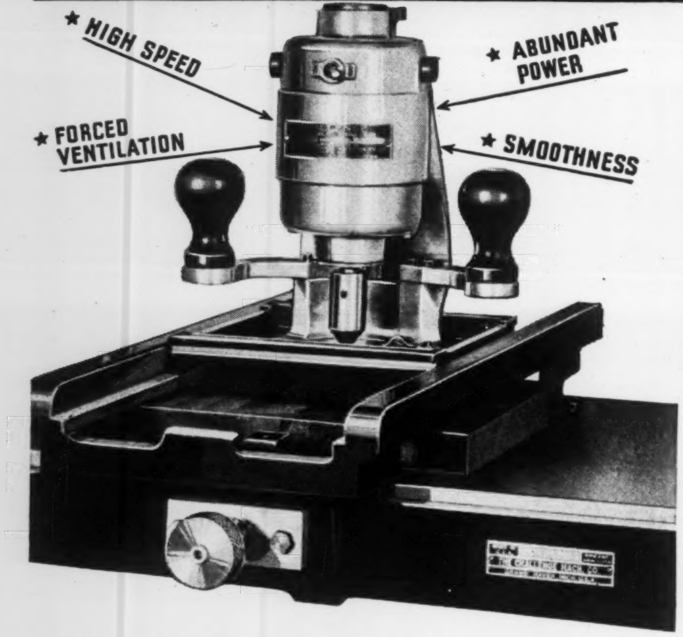
WHEREVER motion is to be imparted from one machine or member to another—Diamond Chain provides the high efficiency pathway.

Catalog 583 contains worthwhile information on the use and selection of Diamond Chains—copy mailed on request. DIAMOND CHAIN & MFG. CO., 435 Kentucky Ave., Indianapolis, Ind. *Offices and Distributors in All Principal Cities.*

DIAMOND ROLLER CHAIN

ROLLING AT EVERY POINT OF CONTACT

"CHALLENGE"
HAD TO HAVE ALL 4

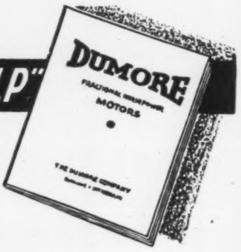


★ The Challenge Machinery Co., Grand Haven, Michigan, conceived the idea of a portable, low-priced router for printers. But, before this router could become a practical reality, certain exacting qualifications had to be obtained in a fractional horsepower (series wound) motor. The Dumore engineers, with their 22 years of experience in designing and adapting power units turned the trick.

Dumore precision built motors are obtainable in many sizes; in h. p. from 1/100 to ¾; in voltages from 6 to 250; in any speed through electric governors (on all sizes) and by speed reducers (on ⅙ h. p. or less). The handy Dumore Catalog tells you how to put the Dumore engineers to work on your own particular problem of applying power. Mail the coupon for your copy today.

DUMORE
FRACTIONAL HORSEPOWER
MOTORS

APPLICATION FOR "HELP"



THE DUMORE CO., Dept. 125-F
Racine, Wis.

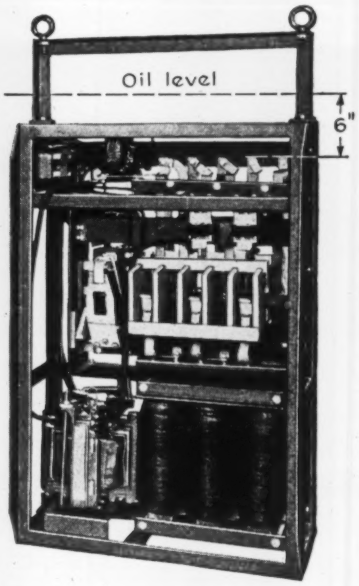
Kindly send me your latest catalog of Dumore fractional h. p. motors.

*Name*__________ *Title*__________
*Firm Name*__________
*Address*__________
*City*__________ *State*__________

weakest point. Thread protectors are placed on all sizes of conduit. Metal caps, which fasten on the ends of the conduit, prevent threads from becoming damaged in transit and thus eliminate the need of chasing or rethreading on the job.

Starters Provide Safe Operation

A NEW line of oil-immersed magnetic starters of the reduced voltage, autotransformer type, in which all arcing contacts are six inches under oil, has been developed by General Electric Co., Schenectady, N. Y. An induction type temperature overload relay is used, also mounted in oil. Either current limit or time limit acceleration is available, and an ammeter attachment can be supplied if desired. Ratings range upward to 600 amperes at 600 volts and 200 amperes at 2500 volts.

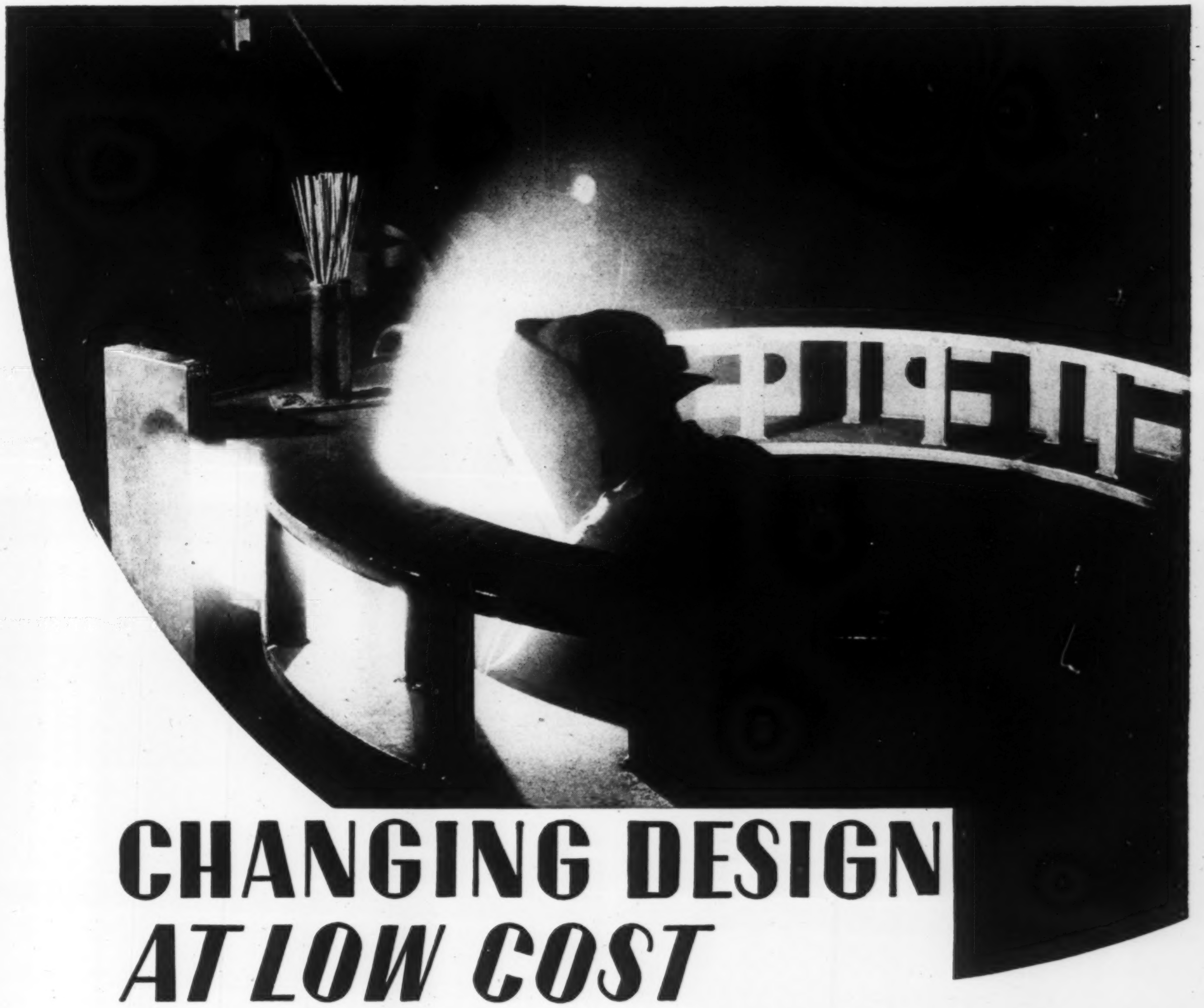


Either current limit or time limit acceleration is available with oil-immersed magnetic starters of the reduced voltage, autotransformer type

All-Rubber Cord Is Attractive

ALL-RUBBER parallel lamp cord of a newly designed type is a recent innovation of Merchandise Department, General Electric Co., Bridgeport, Conn. Designated as type PO-SJ "Special", the new cord is unusual in that both copper conductors are insulated simultaneously with at least a 1/32-inch wall of high-grade rubber. It is claimed that this method of fabrication affords good insulation and abrasion characteristics and, in addition, permits easy separation of the individual conductor for assembly purposes.

The cord has been especially styled to present an attractive appearance. It has a series of



CHANGING DESIGN *AT LOW COST*

● Here's a case where a manufacturer has discovered the advantages and economies of rolled steel in machine construction. A stator frame is being welded up from rolled steel. Notice the cleanness and simplicity of design. Every pound of metal counts; there is no waste weight.

The design or size of this frame could be altered at low cost. That's one of the big advantages in using rolled steel: design can be flexible. You can meet special requirements, special engineering demands.

Check this list of advantages to see how rolled steel would simplify your manufacturing:

- ❶ **Cheaper . . . for most parts.**
- ❷ **Reduces loss due to defects or discards.**
- ❸ **Permits inexpensive changes in design.**
- ❹ **Faster production . . . particularly of new and unstandardized parts.**
- ❺ **Reduces inventory and pattern storage.**
- ❻ **Permits prompt adaptation of standard design to special requirements.**
- ❼ **Eliminates excess weight.**
- ❽ **Modernizes appearance.**

ILLINOIS STEEL COMPANY
208 SOUTH LA SALLE STREET, CHICAGO, ILLINOIS
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United States Steel US STEEL *Corporation Subsidiaries*

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Time, Money
and Trouble

Herewith are shown a few of the thousands of different FIBRE PARTS which we have been called upon to produce—many of which require the following machine operations: Drilling, Turning, Reaming, Counter-boring, Milling, Shaving, Shearing, Punching, Forming, Upsetting, Knurling, Slotting, etc.

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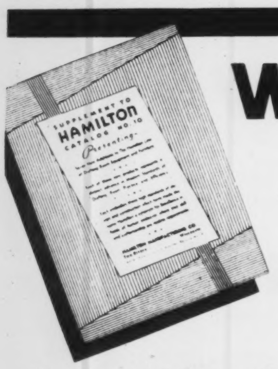
PIONEERS IN FIBRE FABRICATION WILMINGTON, DELAWARE



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Seven modern developments in drafting room equipment are described and illustrated in a New Supplement to Hamilton Catalog No. 10. Ask your dealer for a copy or paste the coupon, below, to a penny postcard.

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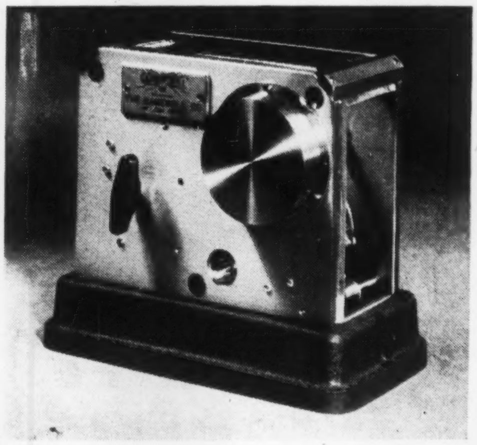
longitudinal ridges in its outer surface, and is available in four standard colors—brown, ivory, black and olive. The cord is approved by Underwriters Laboratories for portable lamps, portable clocks and similar appliances which are not likely to be moved frequently but which require a cord of attractive appearance.

Relay Controls Machine Operation

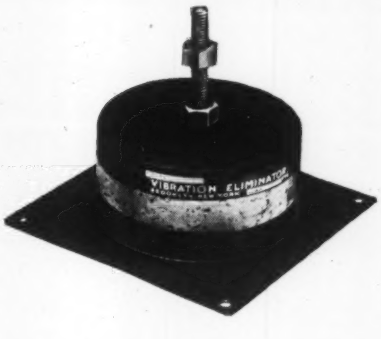
STARTING or stopping of machine equipment is one of the uses for the new selective relay introduced by Gamewell Co., Newton, Mass. In the unit, shown herewith, governing devices are provided for controlling the operation of the contacts. These devices are adjusted so as to give the relay a margin of safety and to guard against the relay being operated from other than a definitely timed signal. Starting mechanism is controlled by the operation of an electromagnet. The enclosure for the mechanism embodies heavy bronze side plates and has beveled edge plate glass panels at the top and ends. Mounting is furnished by a hollow iron base which encloses the controlling magnet and the terminal panel. Finish of the base is black crystal lacquer.



Governing devices control operation of contacts in selective relay

Unit Dampens Vibrations

CONSISTING chiefly of a base stamping and supporting housing to which the leg or base of the machine may be rigidly fastened, the vibration eliminator being manufactured by Vibration Eliminator Co., 41-26 Thirty-seventh street, Long Island City, N. Y., relies for its efficiency in the various sizes upon a new table of selected loadings on pure natural cork. Adequate loadings and ease of installation are thus assured. The isolating materials used in the unit, shown herewith, will maintain its efficiency during the life of the machine and is not affected by water, oils or temperature changes. It does not take a permanent set under excessive loading, and will not further compress after the initial compression. Natural cork has a time lag in its return after compression which prevents a bouncing action.



Natural cork combats vibration in improved vibration eliminator

Coupling Reduces Vibration

ELIMINATION of the transmission of noise and motor torque vibration from the motor to the driven shaft is the principle on which the drive coupling for fractional horsepower motors being offered by Guardian Utilities Co., 1023 East Forty-sixth street, Chicago, is designed. Made of flexible rubber, the coupling, shown herewith, is treated to resist the action of oils, and is offered in various lengths to eliminate the need for shaft extensions.

Flexible rubber is treated to resist the action of oils in drive coupling for small motors

The new device will operate under reasonable lateral or angular misalignment without binding, friction or noise. It is particularly suitable for use with cushioned or spring motors, either base or flange mounted, and affords convenient alignment of the motor and the driven shaft. Made in lengths from 2½ inches up, and with any combination of bores, 5/16, 3/8, 7/16 and ½-inch, the coupling has been applied to oil burners, stokers, printing equipment, small pump units, bakery machines, etc.

Infinite Adjustment Provided

TIME controls, designed to repeat one or two operations or processes as often as desired, in which provision has been made for unusually flexible choice of periods during which the con-

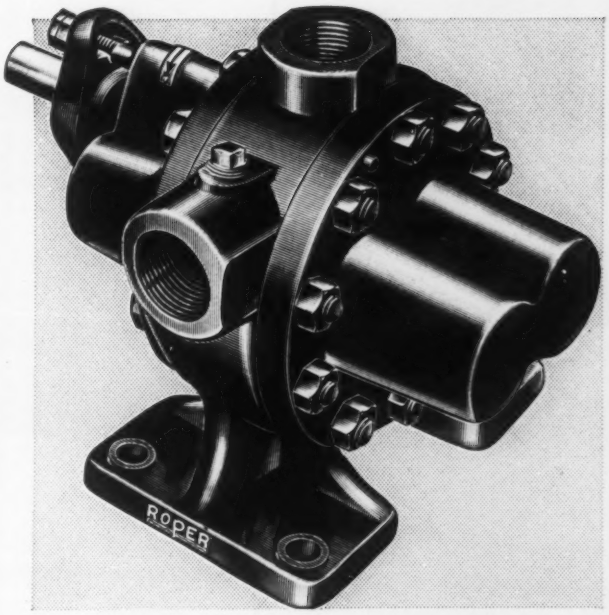


Fig. 999

ROTARY PUMPS

for Hydraulic Power Applications

- *Full Ball Bearing Design*

909 Series—Capacity, 10 to 50 G.P.M. (larger capacity if required). Pressure, 750 lbs.

996 Series—Capacity, 4 to 200 G.P.M. (larger capacity if required). Pressure, 300 lbs.

- *Sleeve Bearing Design*

997 Series—Capacity, 80 to 700 G.P.M. Pressure, 100 lbs. (lubricating liquids) 40 lbs. (non-lubricating liquids).

999 Series—Capacity, 1 to 500 G.P.M. Pressure, 100 lbs.

- Equal size gears operate at same speed.
- Accurately hobbed gears keyed and pressed on to shafts.
- Extra long large bearings.
- Carefully machined case.
- Rugged cast-iron construction.

Write for Bulletin R5MD

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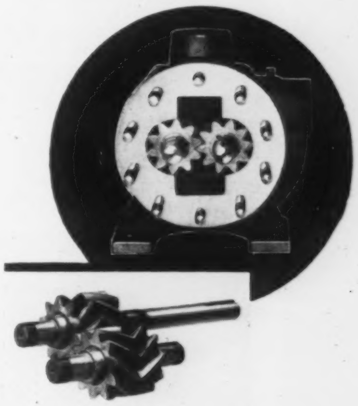
ROCKFORD, ILLINOIS, U.S.A.



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2. How you can eliminate discoloration, brittleness and bad odor from vellum tracings?
3. That it is possible to make a pencil tracing that will reproduce approximately as well as an ink tracing—thereby eliminating the expense of ink work?
4. What simple process is used to make black-line prints directly from the tracing—without the use of a negative and *faster* than blue prints?
5. How you can make extensive alterations on part of a tracing without redrawing the entire tracing?

THE ANSWERS TO THESE QUESTIONS—AND TO MANY OTHERS BESIDES—ARE IN OUR NEW, FREE BOOK, "TEN DOORS TO PROGRESS." MAIL THE COUPON FOR YOUR COPY.

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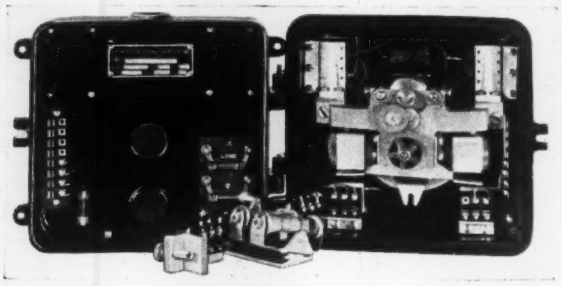
trolled actions take place are being offered by Automatic Temperature Control Co., Philadelphia. The time controls in the new series 1274-5-6, shown herewith, will handle a repetitive action or operation requiring a definite time period or cycle with either the same or different time period between successive time cycles.

The time cycle and also the interval between successive cycles is infinitely adjustable with an accuracy of setting to within a split scale division of the respective dial ranges selected. Parts have been so grouped on the chassis that adjustment is simple. Jack connections permit removal of parts without disturbing the wiring. Settings remain accurate despite vibration. Special contact-metal transmits current even when oxidized. The control units are available in 110 volt alternating current or 220 if especially ordered.



Time cycle and interval between cycles is infinitely adjustable with new control

Offers Colored Valve Wheels

THE INDEXING value of color has been adapted to a new type of valve wheel of Jenkins Bros., Bridgeport, Conn., to designate valves for steam, water, air or any other fluids and gases. The wheels, molded of plastic materials, are available in five standard colors, blue, red, black, green and gray and are offered un-

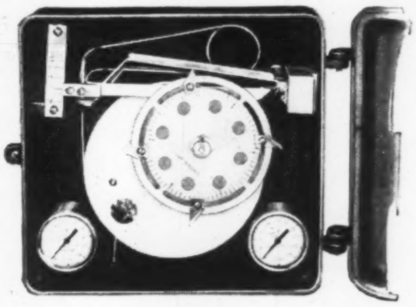
WATER
WASTE

Color has been adapted for its indexing value to new type of valve wheel marked or with five standard service markings molded in relief. The company also offers to make up wheels of special color or with special markings.

Intermitter Controls Operations

AUTOMATIC, intermittent operation of diaphragm valves or other diaphragm-operated devices is provided by a new control instrument of Taylor Instrument Cos., Rochester, N. Y. The intermitter, shown herewith, differs in function from the time-cycle controller in that it is limited to the repetition of a single operation whereas the latter is capable of performing a number of different operations during the revolution of the cam.

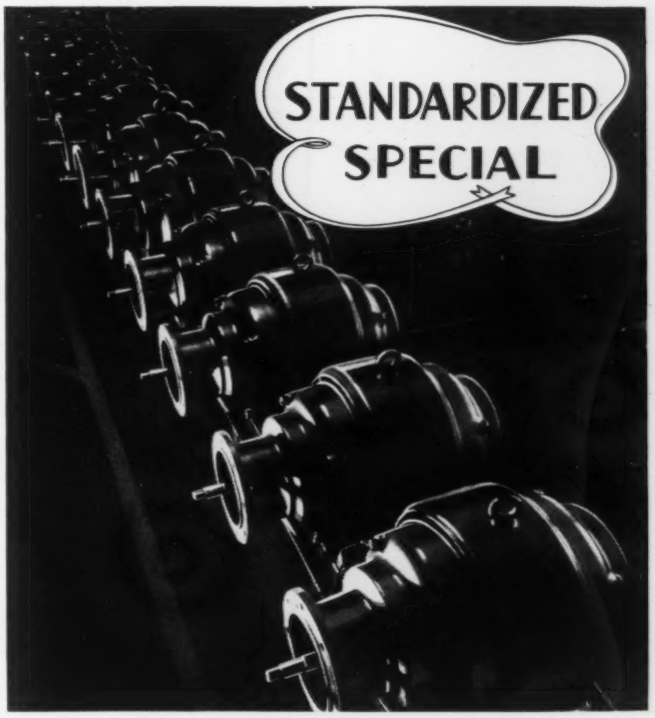
Instead of employing the conventional fixed cam to time the operations, the intermitter has a circular cam on which the proper number of actuating lugs may be placed; the number of lugs corresponding with the number of operations to be performed during the rotation of the cam. The duration of each operation is adjustable by moving the bracket carrying the nozzle (upper left corner of case) so that its scribe mark is opposite the desired time interval on the scale; the higher the position of the nozzle, the shorter the period of nozzle closure and the duration of the operation. It is by these arrangements that any change in either the number or duration of the operations, or the interval between, is possible without replacing or cutting the actuating cam.



Control instrument governs intermittent operation of diaphragm-operated devices

Adjustor Controls Voltages

DESIGNED for use with small alternating current generators, synchronous motors, synchronous condensers and direct current generators, a new small generator-voltage adjuster has been introduced by General Electric Co., Schenectady, N. Y. The type G-4 adjuster, shown herewith, consists of a voltage-sensitive element of the movable-core solenoid type which directly operates, through levers, a wide-range, quick-acting rheostat. The rheostat is connect-



MASTER MOTORS in sizes from 1/10 to 100 h. p. designed both electrically and mechanically to meet your particular needs, are available under the Master plan of controlled production without the delays and high costs which frequently deter the choice of an individually designed motor elsewhere. Progressive, realistic men who think for themselves, who know values, and who have sound ideas of their own about design, have made good use of Master Standardized Special motors to greatly improve their motor driven applications. Master engineers are eager to aid you in selecting the correct motor for your needs.

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—for circulating oil for coolant or lubrication

—steady flow—runs either direction
—simple construction—dependable

—Ask about the

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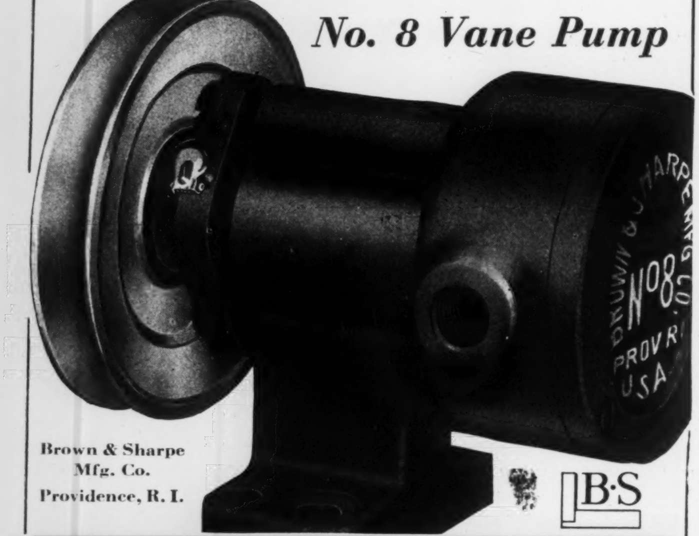
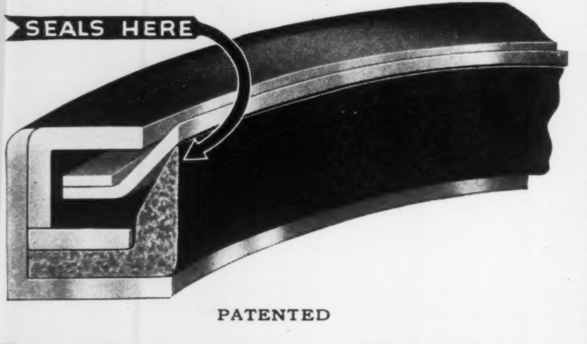


Brown & Sharpe
Mfg. Co.
Providence, R. I.

B·S

Brown & Sharpe Pumps
Geared — Vane — Centrifugal



PATENTED

Gits Precision Oil Seal

Construction Exclusive Feature

Note the improved form of flexible leather washer which prevents the leakage of oil from the housing.

The leather washer is tapered where the pressure of the flat spring clamping ring is applied.

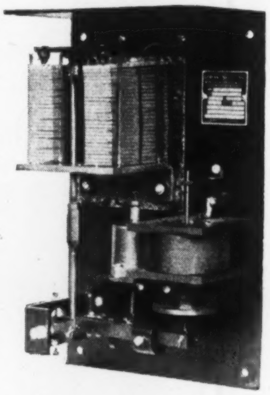
The flexibility of the tapered leather requires but a slight pressure to be contracted and effectively seal with minimum friction on shaft.

The sharp edge of the tapered washer shears the oil film preventing escape of oil.

Send for Catalogue

GITS BROS. MFG. CO.
1851 S. Kilbourn Avenue - - Chicago, Ill.

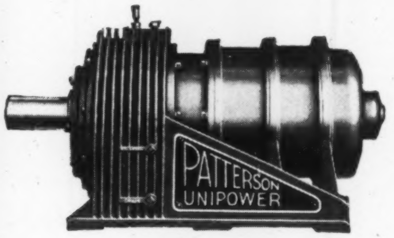
ed in the exciter (or direct current generator) shunt field circuit, and any change in voltage is corrected by direct action of the solenoid on this rheostat. The solenoid is used for either alternating or direct current and, in either case, is excited through a fixed resistor from the generator armature potential. An air dash-pot provides anti-hunting action.



Any change in voltage is corrected by action of a solenoid on a rheostat in generator-voltage adjuster

Reduction Drive Has No Gears

DEVELOPMENT of its Unipower gearless reduction drive into a complete line of horizontal types ranging in size from ¼ to 100 horsepower at all speeds has been announced by Patterson Foundry & Machine Co., East Liverpool, O. The units, shown herewith, are so designed that any standard frame size replacement motor may be installed upon them. Output shafts are on centers with the motor shafts.



Any standard frame motor may be used with gearless reduction drive

Rubber Plug Is Styled

STYLED in a modernistic manner to harmonize with modern appliances and interior decorations, a new all-rubber plug has been announced by the Merchandise Department, General Electric Co., Bridgeport, Conn. Designed to be molded directly on to No. 18 rubber cord, the plug is claimed to be safe and reliable. It bears the Underwriters' Laboratories seal of approval. The plug is designated as the Moderne No. 30.

Sculptural Methods Aid Design Engineers

(Concluded from page 28)

cient contour from the standpoint of aerodynamics. The new Comet train also was first built in model form, and tested in a wind tunnel before actual construction began.

Experiences of designers in the automobile and railroad fields, as well as those in the machine tool and general machinery fields speak well for the use of models. Instances of the latter are exemplified by *Figs.* 4 and 5, which are models of machines developed by Heald Machine Co., and Anker-Holth Mfg. Co. Inc., respectively. Their value to the designer is best expressed by, "Seeing is Believing."

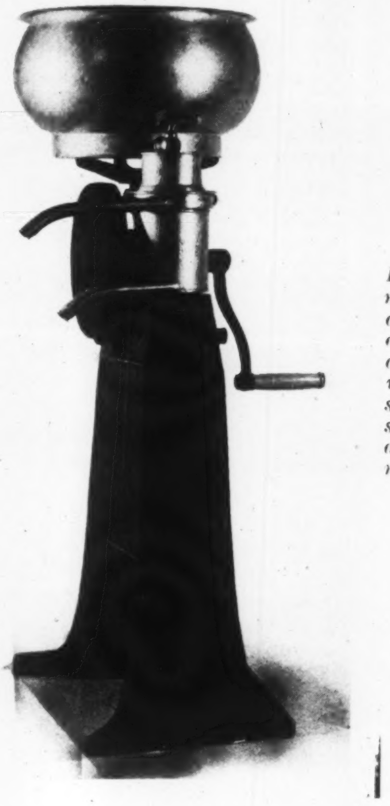


Fig. 5—This plaster model of a cream separator was constructed after a composite design had been developed from forty-six different ideas submitted by a group of artists. Dies and molds were made from the model

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Two giants of the air made headlines recently. In Russia the world's largest land plane, "Maxim Gorki," crashed and was destroyed; in Germany the huge flying boat Do-X which made a famous transatlantic flight five years ago, was placed in the Reich aviation museum which will be opened in the near future. The Soviets, undaunted by their tragedy, announced immediately that three new planes of the same type will be built to replace the ill-fated ship.

Timing the "Sport of Kings" with BODINE Motors

When an "Omaha" comes thundering down the stretch, showing his heels to the field, his running time is accurately recorded by a Kirby electric timer, driven by a Bodine Governor-Controlled Motor.

This is but one of hundreds of unusual and special devices in which Bodine Motors are used. Bodine Motors can be found driving business machines, movie projectors, laboratory instruments, electric turntables, traffic control signals, and many other mechanisms. The Bodine line includes practically every known form of fractional horsepower motors—A. C. and D. C.—1/1300 to ¼ H. P.—constant or variable speed.

Bodine Motors are engineered for your product—"tailored" to fit. Let Bodine engineers study your machines and submit recommendations. Write Bodine Electric Co., 2258 W. Ohio St., Chicago, Ill.

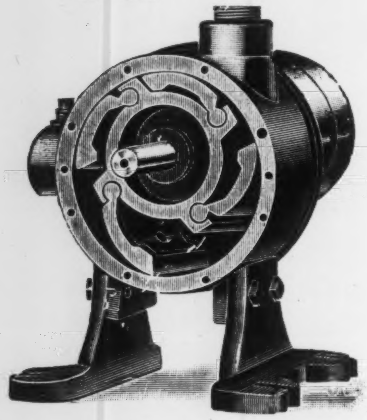
BODINE

BODINE FRACTIONAL H. P. MOTORS

ENGINEERED FOR YOUR PRODUCT

The Machine Designers
Favorite Air Pump

Favorite because of its numerous sizes, its simple lines of construction, but above all because of its reliability—its positive performance which—just because it is so simple in design—can never fail to give its best.



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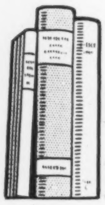
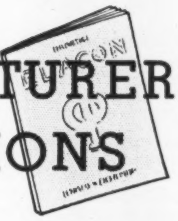


MANUFACTURERS' PUBLICATIONS



ALLOYS (STEEL)—Stainless steels employed to resist chemical corrosion are discussed in a bulletin issued by Republic Steel Corp., Massillon, O., known as Form ADV 146. The attractive publication covers the use of the various metals in the textile industry, bringing out the chemicals which must be resisted and the reasons for choice of material for the machines.

BASES—Vibration eliminators, new shock absorbers or cushions for machinery, are introduced in a folder of Vibration Eliminator Co., Long Island City, N. Y.

BEARINGS—Complete data on standard appliances for antifriction bearing mountings, including both closed and open covers, is given in bulletin B of Bearing Appliance Co., Ardmore, Pa. Tables and an explanation of the specification of the appliances are included.

CAST PARTS—Meehanite Metal Corp., Pittsburgh, has prepared bulletin No. 4 on the wear resistance of Meehanite metal. The bulletin includes, in addition to a complete presentation of the problem, typical applications of the metal.

CONTROLS (ELECTRICAL)—Knife switches are the subject of bulletin GEA-2127 recently issued by General Electric Co., Schenectady, N. Y.

CONTROLS (ELECTRICAL)—Automatic Temperature Control Co., Philadelphia, has prepared catalog TC—bulletin CRD on its line of time controls designed to repeat one or two operations or processes as often as desired. Provision has been made for flexible choice of periods during which the controlled actions take place.

DRIVES—Winfield H. Smith, Inc., Springfield, Erie Co., N. Y., is distributing Catalog No. 28 which includes complete engineering data, dimensions and similar information on its full line of speed reducers, and other transmission machinery.

DRIVES—Link-Belt's positive self-aligning idler for troughed conveyor belts is described and illustrated in a new folder. The discussion of the design features includes particular reference to the purpose of guide and self-aligning idlers which automatically keep the belt central within desired limits by training it back into line without need of an attendant.

FASTENINGS—The entirely new method by which Fibro Forged Screws, patented by Holo-Krome Screw Co., Bristol, Conn., are made is featured and explained in detail in a comprehensive booklet of the company. In addition, the publication gives considerable engineering data on hollow head screws including formulas, threads and screw thread data and other information of interest to designers and engineers.

FINISHES—A new method of applying Bonderite, known as Spra-Bonderizing, is presented in a new bulletin of Parker Rust-Proof Co., Detroit. Bonderizing is a finishing process which protects parts against rust and thus lengthens their life.

MOTORS—Howell Electric Motors Co., Howell, Mich., has prepared a bulletin on its line of Red Band motors which gives a complete description of each motor in the line, including its characteristics, methods of manufacture and suitable applications. Illustrations of the motors in the line are included.

MOTORS—Information of value to motor users is presented in simplified and condensed form in catalog No. 35 of Diehl Mfg. Co., Elizabethport, N. J. In addition to photographs and descriptions of the motors in the line, the catalog gives the characteristics and similar engineering information.

MOTORS—Century Electric Co., St. Louis, has prepared a bulletin on its new line of polyphase motors, from 1/6 to 600 horsepower, in open, enclosed, explosion-proof totally enclosed fan cooled, gear splash proof, multispeed, general purpose and special characteristic types. The motors have been especially designed to satisfy the requirements of air conditioning and similarly exacting applications.

PLATES—A size card for sheared and universal rolled plates and heavy plates widely used in the fabrication of welded frames and other units of machinery and equipment has been prepared by Lukens Steel Co., Coatesville, Pa. Included on the card are sizes rolled on the 206-inch plate rolling mill of the company, and thick plates up to 25 inches.

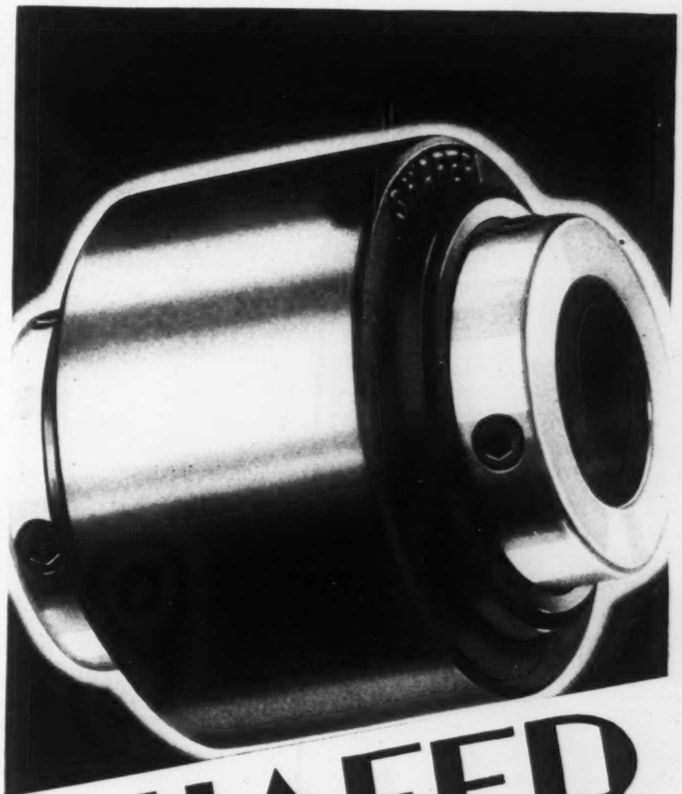
PUMPS—Centrifugal pumping units designed as single parts incorporating single suction, single stage pumps and squirrel cage motors are presented in a catalog insert bulletin recently published by Allis-Chalmers Mfg. Co., Milwaukee.

TUBING—One of the most complete data books ever issued on tubing has been made available by Summerill Tubing Co., Bridgeport, Montgomery County, Pa. The bulletin contains complete data on mechanical tubing including the many shapes available, dimensions and properties, grades, production processes and similar information. Also covered are aircraft, pump, fuel injection, composite and pressure tubing. Tables of weights per foot and engineering data of general character, and stainless corrosion data, definitions of terms, SAE numbering system and a discussion of metals and alloys are included.

WELDED PARTS AND EQUIPMENT—Heavy mineral coated electrodes, what they are, how they are employed and similar topics are discussed in boklet No. 2 of Metal & Thermit Corp., New York. The entire line of electrodes is described.

Research Publications

1934 *Revised Standard Covering Screw Threads.* The 1934 revision of the "Standard Screw Threads for Bolts, Machine Screws, Nuts, and Threaded Parts" is based on the requirements of industry as reflected by comments received since the publication of the 1924 report, and also upon information obtained through an extensive survey of American industrial



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roller bearing
CARTRIDGE UNIT

● **Simplest installation, natural self-alignment, and convenient shaft removal without disturbing the bearing assembly are features of the Shafer Cartridge Unit. The exclusive Shafer CONCAVE roller design combines radial-thrust roller bearing capacity and natural, free-rolling self-alignment in a single compact bearing.**

Available in a full range of sizes:
Cartridge Unit • Pillow Blocks
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Radial-thrust Roller Bearings

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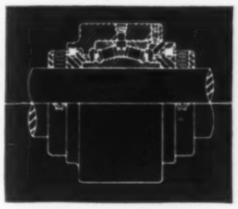
Note piston ring seal and double end square ☐ drive collars

SHAFER
BEARING CORPORATION
6513 WEST GRAND AVENUE • CHICAGO, ILL.

screw thread practice conducted in 1931 by the sectional committee on standardization and unification of screw threads of American Society of Mechanical Engineers with the co-operation of the National Bureau of Standards. Significant developments recorded in the 1934 standard are the dimensions and tolerances for the 8-pitch, 12-pitch and 16-pitch thread series, and the increase in the minimum minor diameter of the internal screw threads in sizes 1 inch and smaller. Published by American Society of Mechanical Engineers, 29 West Thirty-ninth street, New York. 60c.

Heavy Duty Antifriction Bearings. The findings of this report are based on data obtained from a three-year experimental program carried out by the American Society of Mechanical Engineers special research committee to determine the possibilities and limitations in applying heavy duty antifriction bearings to the roll necks of rolling mills. The report contains comprehensive information dealing with power requirements, elastic deformation of rolls during cold rolling, resistance to compression of mild steel during hot rolling under a variety of conditions, resistance to compression of several alloy steels during cold rolling under tension, effect of friction between material and rolls, data permitting evaluation of forces produced during rolling, comparative cost figures for both roll neck and ordinary sliding bearings, showing the possibilities and limitations of each type of bearing from an economcal standpoint. Published by American Society of Mechanical Engineers, 29 West Thirty-ninth street, New York. $1.50.

The Creep and Fracture of Lead and Lead Alloys, by Herbert F. Moore, Bernard B. Betty and Curtis W. Dollins. A considerable number of tests to fracture lead and lead alloys under steady load and under repeated cycles of reversed bending have been made. The apparatus for such tests is described, and tests results are given both for steady load tests and for reversed bending tests. A comparison of the results of tests to failure under these two conditions shows that both produced spreading cracks, but that a steady load does not start a crack until fracture is imminent. Extensive metallographic studies of creep and fracture of lead have been made, and evidences have been obtained of intracrystalline slip under short time tests, and of rotation of crystalline grains under long time tests—at least, of rotation of grains on the surface. Published as bulletin No. 272 by Engineering Experiment Station, University of Illinois, Urbana, Ill.

Applied Working Deflection Principles of Helical Spring Design, by Walter H. Roe. Charts and tables in this booklet are based upon an entirely different method than any heretofore published, as they are based on the working deflection or working range of the spring, which is usually known or easily determined, rather than upon the total deflection of the spring, which in nearly every case is an unknown factor. By using the working deflection, instead of the total deflection, it is possible to take into consideration both he maximum and minimum stresses, and while it is generally known that this minimum stress is just as vital to the life of the spring as the maximum stress, these are the only charts and tables which take this fact into consideration in the computations. The charts are so constructed and correction factors are given for the tables which makes them adaptable to carbon and chrome vanadium, round and square wire, and for wire of phosphor bronze, brass and Monel metal. Published by Walter H. Roe, Tiffin, O. 8 pp. $1.

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Directory of Plastics

Compiled for the assistance of engineers engaged in design of machinery

BECAUSE of the unprecedented interest in plastic materials among designing engineers, every effort is being made to maintain a complete and up-to-date *Directory of Plastics*. The first edition of this directory appeared in the February issue of MACHINE DESIGN. Supplementary additions to that listing are as follows:

FIBERLOID—A cellulose nitrate plastic furnished in sheet, rod and tube form. It can be fabricated by molding, turning or machining into any desired shape. Fiberloid Corp., Indian Orchard, Mass.

FIBERLON—A cast phenolic resin that can be turned or machined. Available in a wide variety of colors. Fiberloid Corp., Indian Orchard, Mass.

FIBESTOS—Slow burning cellulose acetate material, flexible and adaptable to any contour or shape. Furnished in a wide variety of colors and not affected by ultra-violet rays of the sun. This material is sold in sheet, rod and tube form. Fiberloid Corp., Indian Orchard, Mass.

GUMMON—Black in color and capable of taking high polish. Has a continuous heat resistance of 600 degrees Fahr. Inert chemically and unaffected by boiling water; impervious to ordinary chemicals with the exception of the stronger acids; resists hot oil and will not shrink, crack, warp or deteriorate with age. Used for insulated parts such as wiring devices and other small units. Garfield Mfg. Co., Garfield, N. J.

HEMIT—Similar in characteristics to Gummon, but not necessarily black. Grade A is an impregnated cold molded plastic employed as insulation. B is gray-white in color and has a heat resistance ranging from 1100 to 1500 degrees Fahr. Used for interior parts of heating devices such as arc shields or where a molded part must withstand an arc. Garfield Mfg. Co., Garfield, N. J.

LAMICOID BONDED METAL—A combination of steel and plastic material that is fire and waterproof. Requires no polishing or refinishing, nonmetallic in sound or touch, flexible with strength and toughness, and resistant to acids, oils and alcohols. Applications include air conditioning cabinets, slot machines, refrigerator cabinets, etc. Mica Insulator Co., New York.

SPAULDING FIBRE—Light in weight, noncorrosive, has no electrolytic action on metals, is an insulator of heat and electricity, does not deteriorate with age and does not melt, soften or distort when subjected to heat under 200 degrees Fahr. Unaffected by oils, alcohol, benzol and other solvents. Available in sheets, tubes, rods, etc. Has a wide variety of mechanical applications. Spaulding Fibre Co. Inc., Tonawanda, N. Y.

TEGIT—Brown or black in color, polished if so desired. Has a heat resistance of 350 to 400 degrees Fahr. Inert chemically, unaffected by boiling water, impervious to ordinary chemicals with the exception of stronger acids, and resists hot oil. Will not shrink, crack, warp or deteriorate with age. Applications include wiring devices and other small insulated parts. Garfield Mfg. Co., Garfield, N. J.

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★ Many leading machine builders find this *direct* variable speed drive exactly what they require for providing their lighter type machines with *instant, accurate speed adjustability*. The REEVES Vari-Speed Motor Pulley applies directly to *standard* shaft extension of any constant speed motor. Operator secures *any* speed he needs over an *infinite* 3:1 range merely by turning a control handwheel, which can be extended to any desired position. . . . In applying this efficient drive, it is not necessary to change the original position of motor on machine—and it frequently is possible to enclose both motor and drive inside the frame of the machine. Either flat-face pulley or sheave pulley can be used on driven shaft. . . . Furnished in seven sizes—fractional to 7½ H. P. Send coupon for catalog.

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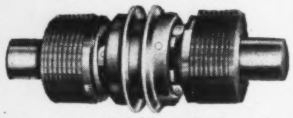

A No. 2 Double-type Pullmore Clutch in oil is used in the power take-off unit which operates the Davey-Troell Power Elevator Tailgate. This device protects men and merchandise against accidents, handles more tonnage quickly and cheaply. The Pullmore contributes to these advantages because it is compact and easily built into the power take-off unit. It is reliable; will not slip, or drop its load. It is efficient, requires less adjustment than others. These same qualities commend Pullmore Clutches to everyone interested in reliable low-cost power transmission and control. Write us, today, for descriptions, sizes, prices; and details of our free consulting engineering service.

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Design for Appearance

is comprehensively treated in
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Harold L. Van Doren

Reprinted from the February,
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MACHINE DESIGN
Penton Building *Cleveland, Ohio*

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MACHINE DESIGN **is a monthly technical publication conceived, edited and directed expressly for those executives and engineers responsible for the creation and improvement of machines built for sale, and for the selection of the materials and parts to be used.**

—Cross Sections—

A STUDY of general magazine advertising often pays the designer. For example, the great stress laid on "fresh" coffee spurred one forthright soul to the development of a machine that beats the claims of all of the companies. It is a coffee roaster for the retailer's use and in a few minutes you can get freshly roasted coffee. Even dated delivery and vacuum cans can't beat that speed.

MANY a designer has puzzled longer over the method of securing units to a shaft than he has over what appears to be more complicated problems, yet the problem constantly bobs up as one of the weak spots in many machines. Now comes a new method of obviating the difficulty. It consists of the perfecting of equipment for cutting a taper spline on the shaft and in the hub of the unit to be attached. Assembly is considerably simplified; locking and strength enhanced.

IF YOU still rassle around daily with one of those complex formulas that has developed a personality that sneers back at you and dares you to get the right answer the first time, you'd better join the growing army of designers that reduce all things to nomograms. A nomogram is the Clyde Beatty of mathematics that can make even the toughest formula lay down and roll over. A dandy we recently came across gives the volume of liquid at any depth in a horizontal cylindrical tank with spheroidal ends by using two simple positions of a straight edge. Try working it long-hand some time!

IT'S AN old truism that if it weren't for the single girls, wives wouldn't be constantly trying to keep up-to-date. Just because you are away ahead of all other manufacturers now making the same line and feel that they can easily be kept in tow, don't try to take it easy. Today there are dozens of different manufacturers in totally unrelated lines, the single girls, that are liable to step out with designs in your field, then you'll have to show more speed than Glenn Cunningham to catch up.

STYLE in design has come a great way in the past few years; evidently the benefits of adversity have been very material. However, a visit to an exhibit of machine art will reveal that some designers are getting off the reservation. Most beauty is the simplest expression of the fundamental purpose of the machine with enclosures and flowing lines combining the utilitarian parts into a composite whole. One machine being exhibited as an example of art in machines is merely an attempt to be artistic, an attempt that reveals itself in bizarre lines and disconnected parts that appear to be the maudlin wanderings of a forced attempt. Efficient, competent appearance is the real aim.

AN ANSWER to the critics who claim that machines are solely responsible for unemployment can be found in the record that it required an average of 6000 man hours to build each of three machines for an automobile builder. Translating, this means that the designing and building of each machine would employ 15 men for 40 hours a week for ten weeks. This does not take into consideration (to mention only a part of those involved) the making of machines to build the new machines, the men making the steel or the parts, the executives required by the machine builder, the transportation men and material involved, or the fact that without the machines the auto builder could not sell nearly as many cars and would not require as many men to build his cars. And a change of models requires a change of machines nearly every year.

BUSINESS AND SALES BRIEFS

COMPLETING the concentration on of its Industrial Materials Division in Newark, O., Owens-Illinois Glass Co., Toledo, O., has recently moved the sales department of this division from Toledo to the Newark plant. Garland Lufkin, formerly manager of the company's factory at Bridgeton, N. J., is now in charge of the entire operation of the Industrial Materials division. J. S. Irvine continues as sales manager.

* * *

T. A. Canty, Baltimore, Md., distributor of arc welding equipment and supplies manufactured by Lincoln Electric Co. has moved his office to larger quarters at 1023 Cathedral street necessitated by substantially increased business.

* * *

Lee Wright has been appointed sales representative for Republic Steel Corp. with headquarters at 401 Atlas building, Salt Lake City, Utah.

* * *

The Philadelphia district sales office of Republic Steel Corp., and subsidiaries, Berger Mfg. Co., and Union Drawn Steel Co., has been removed to Broad Street Station building, 1617 Pennsylvania boulevard. J. B. DeWolf continues in charge of the office as district sales manager.

* * *

J. K. B. Hare, sales executive of Westinghouse Electric & Mfg. Co., has been appointed manager of the Buffalo office of the company. Mr. Hare takes the office made vacant by the promotion of H. F. Boe to the position of assistant manager of the Eastern district, with headquarters in New York.

* * *

Morse Chain Co., Ithaca, N. Y., has elected the following officers: D. B. Perry, president; C. J. Kenerson, vice president, general manager and treasurer; N. K. Van Osdol, secretary and assistant general manager; S. B. Waring, assistant secretary and assistant treasurer. Frank M. Hawley has been appointed sales manager of the automotive division and manager of the Detroit plant of the company.

* * *

Paul S. Menough has been appointed representative for the Pennsylvania district for Michiana Products Corp., Michigan City, Ind., makers of heat and corrosion resistant alloy castings. Mr. Menough's office will be located in the Chamber of Commerce building, Pittsburgh. William B. Cooley, 433 North Capitol avenue, Indianapolis, has been appointed to handle the sale of castings for the company in the Indiana territory.

* * *

James Caven Foster has been appointed general manager of sales for Jones & Laughlin Steel Corp., Pittsburgh. He had been manager of sales in the wire department of the company. Mr. Foster has been succeeded as manager of wire sales by A. W. Herron Jr., who, until his recent appointment, was district sales manager for the company at Cincinnati. Succeeding to the Cincinnati post vacated by Mr. Herron is M. M. Harper, formerly assistant district manager of sales.